SECTION 260500
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Common electrical installation requirements.
3. Demolition.
4. Cutting and patching for electrical construction.
5. Touchup painting.
6. Disposition of existing materials and equipment.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Comply with State and /or City Code requirements.

D. All materials shall meet the standards of the following institutes where applicable:

1. National Fire Protection Association (NFPA)
2. American Society of Testing Materials (ASTM)
3. American National Standards Institute (ANSI)
4. National Electrical Manufacturer's Association (NEMA)
5. Institute of Electrical and Electronic Engineers (IEEE)

1.3 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Section 083100 "Access Doors and Panels."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 078400 "Firestopping."

E. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
   1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
   2. Core drilling through post-tensioned slab: The existing post-tensioned slabs contain post-tensioned tendons that must not be damaged or broken. No nailing, drilling, cutting or other disruption to the slab is allowed without prior written approval by the structural engineer. Contractor shall positively locate the existing tendons and submit to the structural engineer for approval a written procedure, including plans showing existing tendon locations and proposed disruption of the slab.

F. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

G. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability. Document results of said testing.

1.4 DRAWINGS

A. The drawings indicate the arrangements of electrical equipment. Review architectural drawings and details for door swings, cabinets, counters and built-in equipment; conditions indicated on architectural plans shall govern. Coordinate installation of electrical equipment with structural system and mechanical equipment and access thereto. Coordinate installation of recessed electrical equipment with concealed ductwork and piping, and wall thickness. Devices, raceway, and electrical equipment in finished and/or public spaces shall be recessed or concealed unless otherwise noted.

B. Do not scale drawings. Obtain dimensions for layout of equipment from Architectural plans and details unless indicated on Electrical plans.

C. Bring discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Architect.

D. Equipment layout is based on one manufacturer's product or from composite dimensions from multiple manufacturers. Where equipment selected for use on the job differs from layout, coordinate space requirements and connection arrangements.

1.5 EQUIPMENT REQUIRING ELECTRICAL SERVICE

A. Review specification sections and drawings for equipment requiring electrical service. Provide service to and make connections to equipment requiring electrical service.

B. Drawings indicate design loads, voltages and corresponding control equipment, feeders, and overcurrent devices. If equipment actually furnished have loads other than those indicated on the drawings or specified herein, control equipment, feeders, and overcurrent devices shall be adjusted in size accordingly at no additional cost to the owner. Such adjustment shall be subject to the review of the Architect.

C. Incidental items not indicated on Drawing or mentioned in Specifications but that can legitimately and reasonably be inferred to belong to the Work or be necessary in good practice to provide complete system, shall be provided though not itemized here in detail.

1.6 SITE INVESTIGATION

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions which may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original condition, with the exception of the work under this contract, before the completion of this project. Existing systems and conditions which are not detailed on the drawings must still be restored to their original condition.

1.7 EQUIVALENTS AND SUBSTITUTIONS

A. The applicable paragraphs for General Requirements, Division 01 apply herein.

B. Basis of Design: The manufacturer's name and product listed on the drawings, or listed first of several names in these Specifications, is used as a basis for design to establish space requirements, a standard of quality and performance.

C. Equivalents: Products of one or more other manufacturer's names listed in these Specifications following the words "or equivalent by" may be selected, subject to paragraph below titled "Contractor's Responsibility for Equivalent and Substitutions".

D. Other Options:
   1. For products specified by naming only one manufacturer, refer to paragraph below under "Substitutions".
   2. For products specified only by performance characteristics or reference standards, select any manufacturer meeting the requirements.

E. Substitutions: Requests for acceptance of a product of manufacturer's name not listed in these Specifications will be considered if any one of the following conditions is met:
   1. The named product is not available because of strikes or discontinuance of manufacture; and the proposed product is equivalent to the named product.
   2. The proposed product is superior to the named product, in the opinion of the Owner's Representative.
   3. The proposed product is equivalent to the named product and its use will be to the advantage of the Owner, by the Owner receiving an equitable credit or cost savings. The Owner's Representative reserves the right to reject any substitution.
   4. Submit proposed substitutions with bid along with alternate price, complete descriptive data and a comparison of the substitute manufacturer's product with specified product. Request for acceptance of a product of manufacturer's name not listed in these Specifications, is subject to the paragraph titled "Contractor's Responsibility Equivalents and Substitutions".

F. Contractor's Responsibility for Equivalents and Substitutions:
   1. Items submitted as a substitution to the Basis of Design or listed general equivalents shall be identified as such and shall include a written request for substitution indicating the following:
      a. Contract Price adjustment.
      b. Contract time adjustment.
      c. Item by item breakdown of differences between Basis of Design and substituted item.
      d. Operation, maintenance and energy cost difference.
   2. Products of manufacturer must match the features, construction, performance and size of those selected for design. Standard catalogued may require certain modifications to meet specified requirements.
   3. The responsibility for providing that specified requirements have been met remains with the manufacturer and Contractor. Should the substituted item fail to perform in accordance with the Specifications, replace same with the originally specified item without extra cost to the contract.
   4. When requesting review of an equivalent or substituted product, submit a comparison chart listing features, construction, performance and sizes of name product versus equivalent or substituted product.
   5. Submittals for review of an equivalent or substituted product will be reviewed for acceptability when the above requirements have been met. Contractor shall be responsible for costs incurred by the Architect and Engineer for review of equivalency beyond initial review.
   6. Coordinate the installation of the product with trades.
   7. Contractor shall be responsible for changes in electric wiring, materials and for other additional costs of construction by trades involved to accommodate the product to perform the same as the product used in the "Basis of Design".
   8. Coordination of General Equivalents and Substitutions: Where Contract Documents permits selection from general equivalents, or where substitutions are authorized, coordinate clearance and other interface requirements with other work.
   9. Provide necessary additional items so that selected or substituted item operates equivalent to the Basis of Design and properly fits in the available space allocated for the Basis of Design.

10. Contractor is responsible for assuring that piping, conduit, duct, flue and other service locations for general equivalents or substitutions do not cause access, service or operational difficulties any greater than would be encountered with the Basis of Design.
11. Failure to comply with these requirements will result in immediate rejection of the request for substitution.

1.8 GENERAL SUBMITTAL REQUIREMENTS

A. Refer to Division 01 for additional requirements.

B. Coordination and Sequencing:
   1. Coordinate submittals 3 weeks (minimum) prior to expected order date so that work will not be delayed by submittals.
   2. Do not submit product data, or allow its use on the project until compliance with requirement of Contract Documents has been confirmed by Contractor.
   3. Submittal is for information and record, unless otherwise indicated, and is not a change order request.
   4. Submitting contractor is responsible for routing reviewed submittals to parties affected including but not limited to electrical, building automation and temperature control, and test and balance subcontractors.
   5. Make submittals for group of similar products or materials or by area of work complete and at one time, not in piecemeal fashion.
   6. Identify submittals with Architect's project name and number, with item designation as indicated on drawings, and referenced to applicable paragraphs of the specifications. Submit in brochure form.
   7. Submittals of products needed to start of Project for its installation, or those requiring a long lead time for assembly or manufacturing, should be submitted before the others.

C. Preparations of Submittals:
   1. Refer to Division 01 requirements.
   2. Provide permanent marking on each submittal to identify project, date, Contractor, Subcontractor, Supplier, submittal name and similar information to distinguish it from other submittals.
   3. Indicate any portions of work, which deviate from the Contract Documents.
      a. Explain the reasons for the deviations.
      b. Show how such deviations coordinate with interfacing portions of other work.
   4. Show Contractor's executed review and approval marking.
   5. Provide space for the Owner's Representative "Action" marking.
   6. Submittals, which are received from sources other than through Contractor's office, will be returned "Without Action".
   7. Submittals shall be presented in a neat and legible fashion and shall be returned "Without Action" if presented in any other fashion.

D. Response to Submittals: Where standard product data has been submitted, it is recognized:
   1. That the Submitter has determined that the products fulfill the specified requirements.
   2. That the submittal is for the Owner's Representative information only, but will be returned with appropriate action where observed to be not in compliance with the requirements.

E. If more than two submittals (either for shop drawings, or test reports) are made by the Contractor due to the incompletion, non-compliance, errors, omissions, etc. the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.

1.9 RECORD DRAWINGS

A. Record drawings shall meet "As-built" and "Record Drawings" requirements for Hennepin County. Coordinate requirements with Hennepin County staff prior to completion.

B. Drawings:
   1. Record of Project progress: Maintain drawings available at the job site for inspection. Keep an accurate, legible and continuously updated record of installed locations and project revisions other than revised drawings issued by the Architect, including source and date of authorization. Utilize only contract drawing symbols for recording the work. Drawing notations to be sufficiently clear in the representation of the work, for utilization by a CADD operator (drafts person) who is not necessarily familiar with the installed work.
   2. Record of Installation: At the conclusion of the work, deliver one (1) set of updated drawings to the Owner's Representative for review. Following the review, Contractor shall have incorporated by a competent CADD operator the installed data represented on the project progress drawings.
   3. Include in Record Drawings the Following:
      a. Revisions, including sketches, bulletins, change orders, written addenda and directives, clarifications and responses generated by requests for information (RFIs), regardless of source of the revision.
      b. Location and configuration of equipment with related housekeeping pads.
      c. Physical routing of raceways, exposed and above ceilings with locations of fire dampers, combination fire/smoke dampers, smoke detectors, power suppies, etc., plainly marked and identified.
      d. Location of room controllers, switches, devices, and sensors.
      e. Physical routing of raceways exposed and above ceiling with locations of accessories, pull points, access points plainly marked and identified.
      f. Location of wall and ceiling access panels.

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

3.2 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section 078400 "Firestopping."

3.3 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Reroute circuits as required to serve equipment not in the demolition area.

C. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

D. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

E. Remove demolished material from Project site.

F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

G. Remove devices on wall or ceilings being removed. Coordinate with other divisions.

H. Assume that existing equipment and fixtures indicated to be reused are in good working condition and can be installed without repairs. Notify the Architect of items found to be in need of repair or in unusable condition for direction or decision. Repair damage to equipment caused in removal or handling

I. Fixtures and other equipment removed and to be-used shall be cleaned before reinstallation. Provide new lamps for reused light fixtures.

J. Added Circuits: Loads and circuits added to existing panelboards shall be balanced between phases. On existing panelboards where circuits are changed, replace panel directories with new typed directories.

K. Material and equipment which is noted or required by the owner to be salvaged and which is not scheduled to be reused or relocated shall be carefully removed and shall be delivered to the owner and stored where directed on the site.

L. Remove abandoned low voltage wiring. Wiring disconnected on one or both ends is considered abandoned unless tagged and labeled “future” or “spare”. Verify with Owner any cabling connected on both ends is still in use prior to removal.

3.4 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.5 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:
   1. Firestopping.
   2. Electrical demolition.
   3. Cutting and patching for electrical construction.
   4. Touchup painting.

3.6 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Section 099000"Painting."
   1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
   2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
   3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.7 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

3.8 DISPOSITION OF EXISTING BALLASTS CONTAINING PCBS

A. Environmental Protection Agency (EPA) Regulations and Minnesota Pollution Control Agency (MPCA) Rules require controlled disposal of fluorescent light ballasts containing polychlorinated biphenyls (PCBs) when removed from service. The ballasts involved were generally manufactured between 1950 and 1979.

B. Provide suitable ballast collection containers at the project site. Check the ballasts in fluorescent fixtures removed from service under this contract. Some ballasts may be labeled to indicate whether they do or do not contain PCBs. Remove from the fixtures ballasts known or assumed to contain PCBs and place them in the designated ballast collection container and arrange for the disposal of the ballasts off the site in manner approved by the EPA and MPCA.

C. Bear cost for ballast recycling.

3.9 DISPOSITION OF EXISTING FLUORESCENT LAMPS

A. EPA Regulations and Minnesota Pollution Control Agency (MPCA) rules require the controlled disposal of fluorescent lamps.

B. Remove existing fluorescent lamps and package to prevent breakage according to EPA Regulations. Ship the lamps to a licensed lamp recycling facility with an approved material handler.

C. Furnish the Owner with a Certificate of Disposal for these lamps, indicating the number of lamps, time and location of disposal.

D. Bear cost for lamp recycling.

3.10 ELECTRIC SERVICE OUTAGE AND ENERGIZATIONS

A. Owner Approval: Electric service outages or energizations required shall be approved by the Owner before outages or energization. Outages shall be scheduled at the convenience of the Owner.

B. Written Request: Requests for outages and energizations shall be submitted in writing to the Owner for approval at the earliest possible date and in no case later than 14 days prior to the outage and/or energization.

C. Cancellation: The Owner reserves the right to cancel or change the scheduling of any outage up to 24 hours before its approved starting time. There shall be no additional cost to Owner for scheduled outages, or for outages re-scheduled at the Owner's request where at least 24 hours' notice has been given by the Owner.

D. Schedules: A minimum of two (2) weeks before the first outage, submit a schedule of proposed sequence of the electric feeder and switchboard outages and energizations. This schedule shall show construction energizations and shall include any weekend work. The schedule shall list the work to be completed during and between each outage.

E. Minimize outages on the Owner's electrical system and employ sufficient workmen so that work will be carried on concurrently at more than one location, when necessary.

F. Before submitting any energization and/or outage requests, provide the owner with evidence that the following requirements have been met:

1. Required equipment and material is on the job site. Related installations that can be worked on without an energization and/or outage are complete, tested, available for inspection, and ready for service.
2. Shop drawings, test reports, installation data, and operational data have been submitted and approved.

3. The energizing and outage schedule has been submitted and approved.

G. Similar outage procedures shall be followed for telecommunications and other services to the facility.

END OF SECTION

SECTION 260519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Copper building wire rated 600 V or less.
   2. Aluminum building wire rated 600 V or less.
   3. Metal-clad cable, Type MC, rated 600 V or less.
   4. Armored cable, Type AC, rated 600 V or less.
   5. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:
   1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2 and 3 control cables.
   2. Section 271313 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.
   3. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.

1.2 DEFINITIONS

A. RoHS: Restriction of Hazardous Substances.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Alanwire
   2. Alpha Wire.
   3. American Bare Conductor
   4. Belden Inc.
   5. Cerro Wire
   6. Encore Wire Corporation.
   7. General Cable Technologies Corporation.
   8. Okonite Company (The)
   9. Service Wire Co.
   10. Southwire Incorporated.

11. United Copper Industries.

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. RoHS compliant.
   3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

E. Conductor Insulation:
   1. Type THHN and Type THWN-2: Comply with UL 83.

2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems.
   2. Allied.
   3. Anixter
   4. Kaf-Tech
   5. Service Wire Co.
   6. Southwire Incorporated.

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. Comply with UL 1569.
   3. RoHS compliant.
   4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:
   1. Single circuit.
   2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Insulated.

G. Conductor Insulation:
   1. Type TFN/THHN/THWN-2: Comply with UL 83.
   2. Type XHHW-2: Comply with UL 44.

H. Armor: Steel, interlocked.

2.3 ARMORED CABLE, TYPE AC

A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in an overall metallic sheath.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems.
   2. Allied.
   3. Anixter
   4. Kaf-Tech
   5. Okonite Company (The)

6. Service Wire Co.
7. Southwire Incorporated.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Comply with UL 4.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors: [Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Insulated.

G. Conductor Insulation: Type THHN/THWN-2. Comply with UL 83.

H. Armor: Steel, interlocked.

2.4 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. 3M Electrical Products
2. AFC Cable Systems, Inc.
3. Gardner Bender.
4. Hubbell Power Systems, Inc.
5. Ideal Industries, Inc.
6. ILSCO
7. NSi Industries LLC.
8. O-Z/Gedney; a brand of the EGS Electrical Group.
9. Service Wire Co.
10. TE Connectivity Ltd.
11. Thomas & Betts Corporation

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper.
2. Type: One hole with standard barrels.
3. Termination: Compression.

PART 3 EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

D. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

E. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

D. Feeders Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

H. Branch Circuits Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.

I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

J. Final Connections to Light Fixtures, Motors, and Vibrating Equipment: MC or AC – this is the only approved installation for these cable types. Use weathertight versions in exterior applications.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

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

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. 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.

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

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

H. Group conductors with phases A, B, C, and neutral together in conduits or raceways regardless of number of sets of conductors, conduits or raceway type.

I. Do not install more conductors in a raceway than indicated on the drawings. A maximum of three branch circuits are to be installed in any one conduit, on 3 phase 4 wire system, unless specifically indicated otherwise on the drawings. No two branch circuits of the same phase are to be installed in the same conduit, unless specifically indicated on the drawings. Where the quantity of wires is not indicated on the drawings for branch circuits (2) #12 copper conductors shall be provided.

J. Conductor size shall be a minimum of No. 12 AWG. Conductor size shall not be less than indicated on the drawings. The minimum size of emergency systems conductors shall be No. 10 AWG. 60 deg. C ampacities shall be used for sizing wire and cable for feeders rated 100 amps and below. 75 deg. C ampacities shall be used for sizing of all wire and cable for feeders rated over 100 amps. This sizing requirement applies to all cables in these size ranges, including those with higher insulation ratings. Use No. 10 AWG for conductors in 120 volt 20 amp branch circuits longer than 100 feet (80 m), and in 277 volt 20 amp branch circuits longer than 200 feet (160 m).

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

D. Stranded conductors shall have termination device crimped onto conductors prior to connection to outlet devices or installed with back-wired devices listed for stranded.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors.
3. Perform each of the following visual and electrical tests:
   a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
   b. Test bolted connections for high resistance using one of the following:
      1) A low-resistance ohmmeter.
      2) Calibrated torque wrench.
      3) Thermographic survey.
   c. Inspect compression-applied connectors for correct cable match and indentation.
   d. Inspect for correct identification.
   e. Inspect cable jacket and condition.
   f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
   g. Continuity test on each conductor and cable.
   h. Uniform resistance of parallel conductors.
4. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
   a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   b. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Test and Inspection Reports: Prepare a written report to record the following:
   1. Procedures used.
   2. Results that comply with requirements.
   3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION

SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes grounding and bonding systems and equipment.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency and testing agency's field supervisor.

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by NETA.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alanwire
2. Burndy; Part of Hubbell Electrical Systems.
3. Dossert; AFL Telecommunications LLC.
4. ERICO International Corporation.
5. Fushi Copperweld Inc.
6. Galvan Industries, Inc.; Electrical Products Division, LLC.
7. Harger Lightning and Grounding.
8. ILSCO.
9. O-Z/Gedney; A Brand of the EGS Electrical Group.
10. Robbins Lightning, Inc.
11. Siemens Power Transmission & Distribution, Inc.
12. Thomas & Betts, a Member of the ABB Group.

2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alanwire
2. Cerrowire
3. General Cable Technologies Corporation.
4. Southwire Incorporated.
5. United Copper Industries.

B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2.

D. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

E. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

F. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.

E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

PART 3 EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

3.2 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Transformer: Ground the secondary side of transformers to establish separately derived system. Size ground conductor as indicated or per NFPA 70.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

3.4 INSTALLATION

A. 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.

B. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

C. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
   2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
   3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 260529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Aluminum slotted support systems.
3. Nonmetallic slotted support systems.
4. Conduit and cable support devices.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
   a. Slotted support systems, hardware, and accessories.
   b. Clamps.
   c. Hangers.
   d. Sockets.
   e. Eye nuts.
   f. Fasteners.
   g. Anchors.
   h. Saddles.
   i. Brackets.
2. Include rated capacities and furnished specialties and accessories.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Ductwork, piping, fittings, and supports.
3. Structural members to which hangers and supports will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:
   a. Luminaires.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. Projectors.

PART 2 PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Allied Tube & Conduit.

b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Material for Channel, Fittings, and Accessories: Galvanized steel.
4. Channel Width: 1-5/8 inches (41.25 mm).
5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.

C. Comply with MFMA-4 factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Cooper Industries.
   b. Flex-Strut, Inc.
   c. Haydon Corporation
   d. MKT Metal Manufacturing
   e. Thomas & Betts Corporation.
   f. Unistrut; Tyco International, Ltd.
2. Channel Width: 1-5/8 inches (41.25 mm).

D. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least one surface.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Allied Tube & Conduit.
   b. B-Line, Inc.
   c. Fabco Plastics
   d. G-Strut
   e. Haydon Corporation
   f. Seasafe, Inc
2. Channel Width: 1-5/8 inches (41.25 mm).
3. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
4. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

E. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Hilti Inc.
2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
3) MKT Fastening, LLC.
4) Simpson Strong-Tie Co.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

PART 3 EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

B. NECA 1.

C. NECA 101

D. NECA 102.

E. NECA 105.

F. NECA 111.

G. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

H. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

I. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

J. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

K. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, according to NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
   6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69 or Spring-tension clamps.
   7. To Light Steel: Sheet metal screws.
   8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Section 099113 "Exterior Painting", Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 260533
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Metal wireways and auxiliary gutters.
   3. Nonmetal wireways and auxiliary gutters.
   4. Surface raceways.
   5. Boxes, enclosures, and cabinets.

B. Related Requirements:
   1. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
   2. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.2 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

1.3 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Source quality-control reports.

PART 2 PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. AFC Cable Systems, Inc.
      b. Allied Tube & Conduit; a Tyco International Ltd. Co.
      c. Anamet Electrical, Inc.
      d. Calconduit
      e. Electri-Flex Company.
      f. FSR Inc.
      g. Korkap
      h. Opti-Com Manufacturing Network, Inc.

i. O-Z/Gedney; a brand of EGS Electrical Group.
j. Perma-Cote
k. Picoma Industries, Inc.
l. Plasti-Bond
m. Republic Conduit.
n. Robroy Industries.
o. Southwire Company.
p. Thomas & Betts Corporation.
q. Western Tube and Conduit Corporation.
r. Wheatland Tube Company; a division of John Maneely Company.

2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. GRC: Comply with ANSI C80.1 and UL 6.
4. ARC: Comply with ANSI C80.5 and UL 6A.
5. IMC: Comply with ANSI C80.6 and UL 1242.
6. EMT: Comply with ANSI C80.3 and UL 797.
7. FMC: Comply with UL 1; zinc-coated steel.
8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. AFC Cable Systems, Inc.
   b. Allied Tube & Conduit; a Tyco International Ltd. Co.
   c. Anamet Electrical, Inc.
   d. Bridgeport Fittings, Inc.
   e. Calconduit
   f. Electri-Flex Company.
   g. FSR Inc.
   h. Opti-Com Manufacturing Network, Inc.
   i. O-Z/Gedney; a brand of EGS Electrical Group.
   j. Perma-Cote
   k. Picoma Industries, Inc.
   l. Plasti-Bond
   m. Republic Conduit.
   n. Robroy Industries.
   o. Southwire Company.
   p. Thomas & Betts Corporation.
   q. Topaz Electric; a division of Topaz Lighting Corp.
   r. Western Tube and Conduit Corporation.
   s. Wheatland Tube Company; a division of John Maneely Company.
2. Comply with NEMA FB 1 and UL 514B.
3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Fittings, General: Listed and labeled for type of conduit, location, and use.
5. Fittings for EMT:
   a. Material: Steel or Zinc die cast.
   b. Type: Setscrew or compression.
6. EMT Fittings Materials:
   a. All Zinc materials shall be ASTM B86 certified
   b. All Zinc Product shall be ZAMAK #3 and/or #7 formula.
   c. All Steel shall be SAE 1050.
7. EMT Fittings Design:
   a. Zinc die cast components shall be ball burnished.
   b. Steel parts shall be zinc plated for corrosion protection.
   c. All Locknuts shall have a dual, precision machined-cut thread, reversible and possess a serrated face on each side.
   d. All set screw products shall be manufactured with a tri-drive head and staked or modified to prevent disassembly.
   e. All fitting throat diameters shall be smooth with no sharp edges or slag.

f. Rain tight products shall have internal sealing rings to create and maintain a rain tight seal.
g. All fittings shall be tested per UL 514B and be listed by Underwriters Laboratories.

8. Transition Fittings:
   a. All transitions fittings (go-to or from-to fittings) or fittings used to transition from one raceway type to another must be UL listed for that application.
9. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. B-Line, an Eaton business
   2. Hoffman; a Pentair company.
   3. Mono-Systems, Inc.
   4. Square D; a brand of Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
   1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.3 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Allied Moulded Products, Inc.
   2. Hoffman; a Pentair company.
   3. Lamson & Sessions; Carlon Electrical Products.
   4. Niedax Inc.

B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Prime coated, ready for field painting.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Hubbell Incorporated; Wiring Device-Kellems
   b. Mono-Systems, Inc.
   c. Panduit Corp.
   d. Wiremold / Legrand.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Hubbell Incorporated; Wiring Device-Kellems
      b. Mono-Systems, Inc.
      c. Panduit Corp.
      d. Wiremold / Legrand.

D. Tele-Power Poles:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Mono-Systems, Inc.
      b. Panduit Corp.
      c. Wiremold / Legrand.
   2. Material: Galvanized steel with ivory baked-enamel finish.
   3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Adalet.
   2. Crouse-Hinds, an Eaton business
   3. EGS/Appleton Electric.
   4. Erickson Electrical Equipment Company.
   5. FSR Inc.
   6. Hoffman; a Pentair company.
   7. Hubbell Incorporated; Killark Division.
   8. Kraloy.
   9. Milbank Manufacturing Co.
   10. Mono-Systems, Inc.
   11. O-Z/Gedney; a brand of EGS Electrical Group.
   12. Plasti-Bond
   13. RACO; a Hubbell Company.
   14. Spring City Electrical Manufacturing Company.
   15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
   16. Thomas & Betts Corporation.
   17. Topaz Electric; a division of Topaz Lighting
   18. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

E. Metal Floor Boxes:
   1. Material: Cast metal or sheet metal.
   2. Type: Fully adjustable.

3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Nonmetallic Floor Boxes: Nonadjustable, round.
   1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).
   1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

K. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

L. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

M. Gangable boxes are prohibited.

N. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Nonmetallic Enclosures: Plastic.
   3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

O. Cabinets:
   1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.
   6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC or IMC.
   2. Concealed Conduit, Aboveground: EMT.
   3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following:
      a. Loading dock.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.

c. Mechanical rooms.
d. Gymnasiums.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC or IMC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew or compression, steel or Zinc die-cast metal fittings. Comply with NEMA FB 2.10 and UL514B.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Do not install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches (300 mm) of enclosures to which attached.

I. Raceways Within 1 ½" of Roof Deck:
1. All raceway shall be installed further from 1 ½" of roof deck or raceway shall be RMC or IMC.

J. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. 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.

L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

P. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

R. Surface Raceways:
   1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
   2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

S. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

T. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service raceway enters a building or structure.
   3. Where otherwise required by NFPA 70.

U. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for [recessed and semirecessed luminaires,]equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

V. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

W. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

X. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel. Do not install boxes back-to-back.

Y. Locate boxes so that cover or plate will not span different building finishes.

Z. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

BB. Set metal floor boxes level and flush with finished floor surface.

CC. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

DD. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

EE. Boxes installed in metal stud and sheetrock walls shall have far-side box support.

FF. Boxes shall be secured to metal studs with spring steel clamp which wraps around the entire face of the stud and digs into both sides of the stud. Clamp shall be screwed into the stud.

GG. Set outlet boxes for flush mounted devices to within 1/8" of finished wall.

HH. Minimum box size to be two gang. For installation of single gang device use properly sized mud ring with thickness to install device within 1/8" of finished wall.

II. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION

SECTION 260544
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   3. Sleeve-seal fittings.
   4. Grout.
   5. Silicone sealants.

B. Related Requirements:
   1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 PRODUCTS

2.1 SLEEVES

A. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

B. Sleeves for Rectangular Openings:
   1. Material: Galvanized sheet steel.
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

C. STI EZ-Path enclosed fire-rated device, containing a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to adjust, remove, or reinstall firestop materials. The pathway shall be UL Classified and/or FM Systems Approved and tested to the requirements of ASTM E814 (UL1479).
   1. Series 22: 1.5 inches (38 mm) high x 1.5 inches (38 mm) wide x 10.5 inches (267 mm) long, volume expansion of fire seal 40 times, inserts into 2 inch (51 mm) cored hole, maintains rating up to 4 hours installed in wall, capacity of approximately 25 CAT5 cables.
   2. Series 33: 3.0 inches (76 mm) high x 3.0 inches (76 mm) wide x 10.5 inches (267 mm) long, volume expansion of fire seal 16 times, inserts into 4 inch (102 mm) cored hole, maintains rating up to 4 hours installed in wall, capacity of approximately 120 CAT5 cables, up to seven can be ganged together, can be lengthened in 6 inch (152 mm) increments, attaches to a 4 inch (102 mm) conduit, rated for up to 4 hours installed in floor.
   3. Series 44: 4 inches (102 mm) high x 4 5/8 inches (118 mm) wide x 14 inches (356 mm) long, volume expansion of fire seal 16 times, inserts into 6 inch (153 mm) cored hole, maintains rating up to 4 hours installed in wall, capacity of approximately 244 CAT5 cables, up to five can be ganged together in walls, up to 16 can be ganged together in floors, rated for up to 4 hours installed in floor.
   4. Approved Equals: Hilti, Metacaulk

2.2 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

H. All cable bundles shall utilize an enclosed fire rated pathway device whenever said cables penetrate rated walls.

END OF SECTION

SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Labels.
   2. Tapes and stencils.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70.

B. Comply with NFPA 70E and Section 260574 "Overcurrent Protective Device Arc-Flash Study" requirements for arc-flash warning labels.

C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:
   1. Black letters on an orange field.
   2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded branch-circuit conductors.
   1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
   2. Colors for 208/120-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
   3. Colors for 480/277-V Circuits:
      a. Phase A: Brown.
      b. Phase B: Orange.
      c. Phase C: Yellow.
   4. Color for Neutral: White or gray.
   5. Color for Equipment Grounds: Green.
   6. Colors for Isolated Grounds: Green with white stripe.

C. Warning labels and signs shall include, but are not limited to, the following legends:
   1. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.3 TAPES AND STENCILS

A. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide; compounded for outdoor use.
   1. Brady Corporation
   2. Carlton Industries, LP
   3. emedco
   4. Marking Services, Inc.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

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

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
   1. Secure tight to surface of conductor, cable, or raceway.

H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

I. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
   1. "EMERGENCY POWER."
   2. "POWER."
   3. "UPS."

J. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
   1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

K. Laminated Acrylic or Melamine Plastic Signs:
   1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high sign; where two lines of text are required, use labels 2 inches (50 mm) high.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Arc Flash Warning Labeling: Self-adhesive labels.
   1. Comply with NFPA 70E and ANSI Z535.4.
   2. Comply with Section 260574 "Overcurrent Protective Device Arc-Flash Study" requirements for arc-flash warning labels.

D. Equipment Identification Labels:
   1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
   2. Equipment to Be Labeled:
      a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
      b. Enclosures and electrical cabinets.
      c. Access doors and panels for concealed electrical items.
      d. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
      e. Disconnects for any equipment provided by Owner or other trade.
      f. All electrical equipment or devices which are not located within sight of their source of power shall have nameplates listing their source of power (panelboard or switchboard name and number) along with voltage, circuit number, and load served.

END OF SECTION

SECTION 260572
OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY

PART 1 GENERAL

1.1 SUMMARY

A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.2 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.3 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

1. Short-circuit study input data, including completed computer program input data sheets.
2. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
    a. Submit study report for action prior to submitting for final approval the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
    b. Revised single-line diagram, reflecting field investigation results and results of short-circuit study.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Short-Circuit Study Software Developer, Short-Circuit Study Specialist.

B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Short-Circuit Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Short-Circuit Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 COMPUTER SOFTWARE

A. Software Developers: Subject to compliance with requirements, provide software by one of the following:
   1. ESA Inc.
   2. Operation Technology, Inc.
   3. Power Analytics, Corporation.
   4. SKM Systems Analysis, Inc.

B. Comply with IEEE 399 and IEEE 551.

C. Analytical features of fault-current-study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:
   1. Protective device designations and ampere ratings.
   2. Cable size and lengths.
   3. Transformer kilovolt ampere (kVA) and voltage ratings.
   4. Motor and generator designations and kVA ratings.
   5. Switchgear, switchboard, motor-control center, and panelboard designations.

D. Comments and recommendations for system improvements, where needed.

E. Protective Device Evaluation:
   1. Evaluate equipment and protective devices and compare to short-circuit ratings.
   2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
   3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
   4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
   5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.

G. Short-Circuit Study Output:
   1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
      a. Voltage.
      b. Calculated fault-current magnitude and angle.
      c. Fault-point X/R ratio.
      d. Equivalent impedance.
   2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. Calculated asymmetrical fault currents:
    1) Based on fault-point X/R ratio.
    2) Based on calculated symmetrical value multiplied by 1.6.
    3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. No AC Decrement (NACD) ratio.
    e. Equivalent impedance.
    f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
    g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 EXECUTION

3.1 EXAMINATION

A. Obtain all data necessary for the conduct of the study.
    1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Architect.
    2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
    3. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.

B. Gather and tabulate the following input data to support the short-circuit study. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
    1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
    2. Obtain electrical power utility impedance at the service.
    3. Power sources and ties.
    4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
    5. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
    6. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
    7. Motor horsepower and NEMA MG 1 code letter designation.
    8. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.2 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on the device characteristics supplied by device manufacturer.

D. The extent of the electrical power system to be studied is indicated on Drawings.

E. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices as follows:
   1. To normal and emergency systems low-voltage load buses where fault current is 10 kA or less.
   2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 125 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
   1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:
   1. Electric utility's supply termination point.
   2. Incoming switchgear.
   3. Low-voltage switchgear.
   4. Standby generators and automatic transfer switches.
   5. Branch circuit panelboards.
   6. Disconnect switches.

3.3 ADJUSTING

A. Make minor modifications to equipment as required to accomplish compliance with short-circuit study.

3.4 DEMONSTRATION

A. Train Owner's operating and maintenance personnel in the use of study results.

END OF SECTION

SECTION 260573
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 GENERAL

1.1 SUMMARY

A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.
   1. Emergency system(s) overcurrent devices shall be selectively coordinated with all supply side overcurrent protective devices.
   2. Study results shall be used to determine coordination of series-rated devices.

1.2 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.3 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.
   1. Coordination-study input data, including completed computer program input data sheets.
   2. Study and equipment evaluation reports.
   3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
      a. Submit study report for action prior to submitting for final approval the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Coordination Study Specialist and Field Adjusting Agency.

B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. The following parts from the Protective Device Coordination Study Report:
         1) One-line diagram.
         2) Protective device coordination study.
         3) Time-current coordination curves.
      b. Power system data.

1.6 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Coordination Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Software Developers: Subject to compliance with requirements, available software developers offering software that may be used for the Work include, but are not limited to, the following:

1. CGI CYME
2. EDSA Micro Corporation
3. ESA Inc.
4. Operation Technology, Inc.
5. Power Analytics, Corporation.
6. SKM Systems Analysis, Inc.

B. Comply with IEEE 242 and IEEE 399.

C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:
   a. Arcing faults.
   b. Simultaneous faults.
   c. Explicit negative sequence.
   d. Mutual coupling in zero sequence.

2.2 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."

F. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
    a. Phase and Ground Relays:
        1) Device tag.
        2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
        3) Recommendations on improved relaying systems, if applicable.
    b. Circuit Breakers:
        1) Adjustable pickups and time delays (long time, short time, ground).
        2) Adjustable time-current characteristic.
        3) Adjustable instantaneous pickup.
        4) Recommendations on improved trip systems, if applicable.
    c. Fuses: Show current rating, voltage, and class.

G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:
    a. Power 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. Cables and conductors damage curves.
    g. Ground-fault protective devices.
    h. Motor-starting characteristics and motor damage points.
    i. Generator short-circuit decrement curve and generator damage point.
    j. The largest feeder circuit breaker in each motor-control center and panelboard.
5. Series rating on equipment allows the application of two series interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Both devices share in the interruption of the fault and selectivity is sacrificed at high fault levels. Maintain selectivity for tripping currents caused by overloads.
6. Provide adequate time margins between device characteristics such that selective operation is achieved.
7. Comments and recommendations for system improvements.

H. Submit separate summary to show emergency system(s) overcurrent devices selectively coordinated with all supply side overcurrent protective devices.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 PROTECTIVE DEVICE COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. The study shall be based on the device characteristics supplied by device manufacturer.

D. The extent of the electrical power system to be studied is indicated on Drawings.

E. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:

1. To normal and emergency systems low-voltage load buses where fault current is 10 kA or less.
2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 125 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:
   a. Inrush current when first energized.
   b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
   c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

H. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

J. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.

K. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:

1. Electric utility's supply termination point.

2. Switchgear.
3. Unit substation primary and secondary terminals.
4. Low-voltage switchgear.
5. Motor-control centers.
6. Standby generators and automatic transfer switches.
7. Branch circuit panelboards.

M. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.

3.3 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:

1. Determine load-flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
2. Determine load-flow and voltage drop based on 80 percent of the design capacity of the load buses.
3. Prepare the load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.4 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the overcurrent protective device study.

1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.

B. Gather and tabulate the following input data to support coordination study. The list below is a guide. Comply with recommendations in IEEE 241 and IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Electrical power utility impedance at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus, three phase and line-to-ground.
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
9. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
10. Maximum demands from service meters.
11. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
12. Motor horsepower and NEMA MG 1 code letter designation.

13. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
14. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices indicated to be coordinated.
    h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    j. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes rms symmetrical.
    k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.5 FIELD ADJUSTING

A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with [short-circuit and]protective device coordination studies.

C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
    1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.6 DEMONSTRATION

A. Engage the Coordination Study Specialist to train Owner's maintenance personnel in the following:
    1. Acquaint personnel in the fundamentals of operating the power system in normal and emergency modes.
    2. Hand-out and explain the objectives of the coordination study, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting the time-current coordination curves.
    3. Adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION

SECTION 260574
OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

PART 1 GENERAL

1.1 SUMMARY

A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.2 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.3 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form.

1. Arc-flash study input data, including completed computer program input data sheets.
2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.
    a. Submit study report for action prior to submitting for final approval the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Arc-Flash Study Specialist and Field Adjusting Agency.

B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
2. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.6 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Software Developers: Subject to compliance with requirements, available software developers offering software that may be used for the Work include, but are not limited to, the following:
1. CGI CYME
2. EDSA Micro Corporation
3. ESA Inc.
4. Operation Technology, Inc.
5. Power Analytics, Corporation.
6. SKM Systems Analysis, Inc.

B. Comply with IEEE 1584 and NFPA 70E.

C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary.

B. Study descriptions, purpose, basis and scope.

C. One-line diagram, showing the following:
1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output: As specified in "Short Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."

F. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."

G. Arc-Flash Study Output:
1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.

g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

H. Incident Energy and Flash Protection Boundary Calculations:
1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Working distance.
6. Incident energy.
7. Hazard risk category.
8. Recommendations for arc-flash energy reduction.

I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

2.3 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch (76-by-127-mm) self-adhesive equipment label for each work location included in the analysis.

B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
1. Location designation.
2. Nominal voltage.
3. Flash protection boundary.
4. Hazard risk category.
5. Incident energy.
6. Working distance.
7. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies:
1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."
2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."

C. Calculate maximum and minimum contributions of fault-current size.
1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except 240-V ac and 208-V ac systems fed from transformers less than 125 kVA.

F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
   1. Fault contribution from induction motors should not be considered beyond three to five cycles.
   2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:
   1. When the circuit breaker is in a separate enclosure.
   2. When the line terminals of the circuit breaker are separate from the work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.
   1. Verify completeness of data supplied on the one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to the attention of Architect.
   2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
   3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.

B. Electrical Survey Data: Gather and tabulate the following input data to support coordination study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
   1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Obtain electrical power utility impedance at the service.
   3. Power sources and ties.
   4. Short-circuit current at each system bus, three phase and line-to-ground.
   5. Full-load current of all loads.
   6. Voltage level at each bus.
   7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
   8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
   9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
   10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
   11. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
   12. Motor horsepower and NEMA MG 1 code letter designation.
   13. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.4 LABELING

A. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:

1. Motor-control center.
2. Low-voltage switchboard.
3. Switchgear.
4. Medium-voltage switch.
5. Control panel.

3.5 APPLICATION OF WARNING LABELS

A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.6 DEMONSTRATION

A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION

SECTION 260923
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Standalone daylight-harvesting switching and dimming controls.
2. Indoor occupancy and vacancy sensors.
3. Switchbox-mounted occupancy sensors.
4. Wall dimmer occupancy sensors.
5. Digital timer light switches.
6. Wall-box dimmers.
7. Emergency shunt relays.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for manual light switches and non-networkable wall-switch occupancy sensors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:
   a. Occupancy sensors.
   b. Vacancy sensors.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.
4. Provide coversheet indicating project title, project location, and vendor contact information.
5. Organize submittal into logical sections and provide table of contents.
6. Provide itemized bill of materials indicating model number and quantity for each product.
7. On datasheets with multiple products, indicate which product is provided under this project.
8. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
9. Manufacturers' catalog sheets with complete technical data for each item being furnished.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media. Provide names, versions, and website addresses for locations of installed software.
3. Device address list.
4. Printout of software application and graphic screens.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Faulty operation of lighting control software.
   b. Faulty operation of lighting control devices.
2. Warranty Period: Two year(s) from date of Substantial Completion.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 PRODUCTS

2.1 DAYLIGHT-HARVESTING SWITCHING CONTROLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Match existing building system if existing.
   2. NexLight Perfect Sense.

B. System Description: System operates indoor lighting.

C. Sequence of Operation: As daylight increases, the lights are turned off at a predetermined level. As daylight decreases, the lights are turned on at a predetermined level.
   1. Lighting control set point is based on two lighting conditions:
      a. When no daylight is present.
      b. When significant daylight is present (target level).
      c. System programming is done with two hand-held, remote-control tools.

D. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with [integrated] power pack, that detects changes in indoor lighting levels that are perceived by the eye.

E. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack[mounted on luminaire], that detects changes in indoor lighting levels that are perceived by the eye.

F. Electrical Components, Devices, and Accessories:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
   3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor shall be powered by the power pack.
   4. Sensor Output: Digital signal compatible with power pack.
   5. Sensor type: Closed loop.
   6. Zone: Single.
   7. Power Pack: Digital controller capable of accepting 4 RJ45 inputs with two outputs rated for 20-A incandescent or LED load at 120- and 277-V ac, for 16-A ballast or LED at 120- and 277-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.
      a. With integral current monitoring
      b. Compatible with digital addressable lighting interface.
      c. Plenum rated.
   8. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lux), with an adjustment for turn-on and turn-off levels within that range.
   9. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc (1080 to 10 800 lux), with an adjustment for turn-on and turn-off levels within that range.
   10. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lux), with an adjustment for turn-on and turn-off levels within that range.
   11. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
   12. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
   13. Test Mode: User selectable, overriding programmed time delay to allow settings check.
   14. Control Load Status: User selectable to confirm that load wiring is correct.

15. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.2 DAYLIGHT-HARVESTING DIMMING CONTROLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Match existing building system if existing.
   2. NexLight Perfect Sense.

B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
   1. Lighting control set point is based on two lighting conditions:
      a. When no daylight is present (target level).
      b. When significant daylight is present.
   2. System programming is done with two hand-held, remote-control tools.
      a. Initial setup tool.
      b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate power pack mounted on luminaire, to detect changes in indoor lighting levels that are perceived by the eye.

D. Electrical Components, Devices, and Accessories:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Sensor Output: 0- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
   3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).

E. Power Pack: Digital controller capable of accepting 4 RJ45 inputs with two outputs rated for 20-A incandescent or LED load at 120- and 277-V ac, for 16-A ballast load or LED at 120- and 277-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.
   1. With integral current monitoring
      a. Compatible with digital addressable lighting interface.
         1) Plenum rated.

2.3 INDOOR OCCUPANCY AND VACANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Match existing building system if existing.
   2. NexLight Perfect Sense.

A. General Requirements for Sensors:
   1. Wall and/or Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
   2. Dual technology.
   3. Integrated or Separate power pack.
   4. Hardwired connection to switch ; and BAS and lighting control system.
   5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   6. Operation:
      a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
      b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
      c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   7. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
   8. Power: Line voltage.

9. Power Pack: Dry contacts rated for 20-A ballast or LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
10. Mounting:
    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
12. Bypass Switch: Override the "on" function in case of sensor failure.
13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.

B. Dual-Technology Type: Wall or Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 3000 square feet (330 square meters) when mounted48 inches (1200 mm) above finished floor.

2.4 SWITCHBOX-MOUNTED OCCUPANCY AND VACANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Match existing building system if existing.
2. NexLight Perfect Sense.

A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox, with provisions for connection to BAS using hardwired connection.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
4. Switch Rating: Not less than 800-VA ballast or LED load at 120 V, 1200-VA ballast or LED load at 277 V, and 800-W incandescent.

B. Wall-Switch Sensor:
1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft. (84 sq. m).
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
4. Capable of controlling load in three-way application.
5. Voltage: Dual voltage, 120 and 277 V.
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
8. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
10. Color: Match device color with Section 262726 “Wiring Devices”.
11. Faceplate: Color matched to switch.

2.5 WALL DIMMER OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Lutron Maestro 0-10 V Dimmer Sensor Series or comparable product.

B. Description:
   1. 0-10V Wall Dimmer Occupancy Sensors:
      a. Compatible with sourcing electronic 0-10 V ballasts/drivers, as per IEC 60929 Annex E.2 0-10 V protocol.
      b. Adjustable sensitivity (high, medium, low, and minimum presets).
      c. Adjustable high/low end trims.
      d. Selectable dimming curve (linear or square law).
      e. Dimmer Features: Locked preset, fade-to-on, fade-to-off.
      f. Turns off lighting after reasonable and adjustable time delay once the last person to occupy the space vacates a room or area. Provide adjustable timeout settings of 1, 5, 15, and 30 minutes.
      g. Selectable option to enable low light feature (automatic-on when ambient light is below threshold). Ambient light threshold to be selectable as either adaptive utilizing occupant feedback (Lutron Smart Ambient Light Detection) or as fixed (high, medium, low, and minimum presets).
      h. Fades lights to off over period of 10 seconds to warn occupant of impending load turn-off.
      i. Provides visual alert for miswire and incompatible load.
   2. Passive Infrared 0-10 V Wall Dimmer Combination Occupancy/Vacancy Sensors:
      a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
      b. 0-10 V control for 0-10 V fluorescent ballasts/LED drivers (8 A load at 120-277 V, 50 mA max control current).
      c. Coverage of 900 square feet (81 sq m) with mounting height of 4 feet (1.2 m).
      d. 180 degree field of view.
      e. Multi-location capability using standard 3-way or companion switch (up to nine companion switches may be connected).

2.6 DIGITAL TIMER LIGHT SWITCH

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Match existing building system if existing.
   2. NexLight Perfect Sense.

B. Description: Combination digital timer and conventional switch lighting control unit, complying with UL 917. Switchbox-mounted, backlit LCD display, with selectable time interval in 10 minute increments.
   1. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 amps at 277-V ac for ballast or LED, and 1/4 horsepower at 120-V ac.
   2. Integral relay for connection to BAS.
   3. Voltage: Dual voltage - 120 and 277 V.
   4. Color: Match device color with Section 262726 “Wiring Devices”.
   5. Faceplate: Color matched to switch.

2.7 WALL-BOX DIMMERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Bryant Electric; a Hubbell company.
   2. Cooper Industries, Inc.
   3. Hubbell Building Automation, Inc.
   4. Intermatic, Inc.
   5. Leviton Mfg. Company Inc.
   6. Lithonia Lighting; Acuity Lighting Group, Inc.
   7. Lutron Electronics Co., Inc.
   8. NSi Industries LLC; TORK Products.
   9. Philips Lighting Controls
   10. RAB Lighting.

11. Sensor Switch, Inc.
12. Square D; a brand of Schneider Electric.
13. Watt Stopper.

B. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

C. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

D. Power Failure Recovery: When power is interrupted for periods up to 1 year and subsequently restored, lights to automatically return to same levels (dimmed setting, full on, or full off) as prior to power interruption.

E. LED Lamp Dimmer Switches: Modular; compatible with dimming driver; dimmer-ballast combination capable of consistent dimming with low end not greater than 10 percent of full brightness
   1. Provide dimmer and driver that are compatible and tested to comply with UL standards.
   2. Continuous Flicker Free dimming range 100% to 1% measured relative light output.
   3. Meets FCC Part 15 Non-Consumer requirements for EMI/RFI emissions in a typical grounded fixture
   4. Provide dimmers with Pulse Width Modulation for both constant current or constant wattage drivers to maintain LED color when dimming, unless noted otherwise on the Luminaire Schedule.

2.8 EMERGENCY SHUNT RELAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Lighting Control and Design; Acuity Lighting Group, Inc.
   2. Watt Stopper.

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
   1. Coil Rating: 120 or 277 V.

2.9 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3.7 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943.23 "Relay-Based Lighting Controls."

B. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

SECTION 262213
LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
   2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
   7. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   8. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
   9. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Source quality-control reports.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
   1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

1.7 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ACME Electric Corporation; Power Distribution Products Division.
2. Dongan Electric Manufacturing
3. Eaton Electrical Inc.; Cutler-Hammer Products.
4. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
5. General Electric Company.
6. Hammond Co.; Matra Electric, Inc.
7. Jefferson Electric, Inc.
8. Marcus Transformer LTD
9. MGM Transformer Company
10. Micron Industries Corporation
11. Mirus International Inc.
12. Powersmiths International
13. Rex Power Magnetics
14. Siemens Energy & Automation, Inc.
15. Sola/Hevi-Duty.
16. Square D Co/Groupe Schneider NA; Schneider Electric.
17. TEMCo Transformers.

B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Comply with NFPA 70.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.

2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
3. Grounded to enclosure.

C. Coils: Continuous windings without splices except for taps.
1. Coil Material: Aluminum.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Welded.

D. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

E. Enclosure: Ventilated.
1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound using a vacuum-pressure impregnation process to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
3. Wiring Compartment: Sized for conduit entry and wiring installation.
4. Finish: Comply with NEMA 250.
a. Finish Color: Gray weather-resistant enamel.

F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

H. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

I. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 80 deg C rise above 40 deg C ambient temperature.

J. Energy Efficiency for Transformers Rated 15 kVA and Larger:
1. Complying with DOE 2016 Amended Energy Conservation Standard for Low-Voltage Dry-Type Distribution Transformers, efficiency levels.
a. 15 kVA: 97.89% efficiency
b. 30 kVA: 98.27% efficiency
c. 45 kVA: 98.40% efficiency
d. 75 kVA: 98.60% efficiency
e. 112.5 kVA: 98.74% efficiency
f. 150 kVA: 98.83% efficiency
g. 225 kVA: 98.94% efficiency
h. 300 kVA: 99.02% efficiency
i. 500 kVA: 99.14% efficiency
j. 750 kVA: 99.23% effifiency
k. 1000 kVA: 99.28% efficiency

K. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

L. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
2. Indicate value of K-factor on transformer nameplate.
3. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.
4. K-13 rating.

M. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

N. Wall Brackets: Manufacturer's standard brackets.

2.4 IDENTIFICATION

A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
   1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
   2. Ratio tests at rated voltage connections and at all tap connections.
   3. Phase relation and polarity tests at rated voltage connections.
   4. No load losses, and excitation current and rated voltage at rated voltage connections.
   5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
   6. Applied and induced tensile tests.
   7. Regulation and efficiency at rated load and voltage.
   8. Insulation-Resistance Tests:
      a. High-voltage to ground.
      b. Low-voltage to ground.
      c. High-voltage to low-voltage.
   9. Temperature tests.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.

B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" or Section 033053 "Miscellaneous Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
   1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
   2. Install neoprene pads for mounting.

D. Secure transformer to concrete base according to manufacturer's written instructions.

E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

G. Do not install any transformer rated 50 KVA or larger above a lay-in acoustic tile ceiling.

H. Do not install any transformers above lay-in acoustic tile ceilings where the space above the ceiling is serving as an air handling plenum. Do not install transformers above any other type ceilings under any circumstances.

I. Suspend hanging transformers with a trapeze of unistrut or angle iron and threaded rod and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
   1. Install neoprene pads for mounting.

J. Provide a local enclosed circuit breaker overcurrent device/disconnect for all transformers not located within sight of primary feeder breaker. Size to be same as upstream overcurrent device.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
   1. Visual and Mechanical Inspection.
      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, and grounding.
      c. Verify that resilient mounts are free and that any shipping brackets have been removed.
      d. Verify the unit is clean.
      e. Perform specific inspections and mechanical tests recommended by manufacturer.
      f. Verify that as-left tap connections are as specified.
      g. Verify the presence of surge arresters and that their ratings are as specified.
   2. Electrical Tests:
      a. Measure resistance at each winding, tap, and bolted connection.
      b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
      c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
      d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

D. Large (Larger Than 167-kVA Single Phase or 500-kVA Three Phase) Dry-Type Transformer Field Tests:
   1. Visual and Mechanical Inspection:
      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, and grounding.
      c. Verify that resilient mounts are free and that any shipping brackets have been removed.

d. Verify the unit is clean.
e. Perform specific inspections and mechanical tests recommended by manufacturer.
f. Verify that as-left tap connections are as specified.
g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:
   a. Measure resistance at each winding, tap, and bolted connection.
   b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
   c. Perform power-factor or dissipation-factor tests on all windings.
   d. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
   e. Perform an excitation-current test on each phase.
   f. Perform an applied voltage test on all high- and low-voltage windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
   g. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

E. Remove and replace units that do not pass tests or inspections and retest as specified above.

F. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
   1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
   2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
   3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

G. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 262416
PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

1.2 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. HID: High-intensity discharge.

E. MCCB: Molded-case circuit breaker.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.
   1. Include materials, switching and overcurrent protective devices, accessories, and components indicated.
   2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
   7. Include dimensioned plans, elevations, sections, and details.
   8. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
   9. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
   10. Detail bus configuration, current, and voltage ratings.
   11. Short-circuit current rating of panelboards and overcurrent protective devices.
   12. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   13. Include wiring diagrams for power, signal, and control wiring.
   14. Key interlock scheme drawing and sequence of operations.
   15. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Include selectable ranges for each type of overcurrent protective device.
   16. Include report of emergency system(s) overcurrent devices selective coordination with all supply side overcurrent protective devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Keys: Two spares for each type of panelboard cabinet lock.
   2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard using this breaker type.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407.

1.9 FIELD CONDITIONS

A. Environmental Limitations:
   1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding [minus 22 deg F (minus 30 deg C)] [23 deg F (minus 5 deg C)] to plus 104 deg F (plus 40 deg C).
      b. Altitude: Not exceeding 6600 feet (2000 m).

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than ten days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.
   3. Comply with NFPA 70E.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
   1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

E. Enclosures: Flush- and surface-mounted cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
   2. Height: 84 inches (2.13 m) maximum.
   3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
   4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
   5. Finishes:
      a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
      b. Back Boxes: Galvanized steel.
   6. Directory Card: Inside panelboard door, mounted in transparent card holder.

F. Incoming Mains:
   1. Location: Top or Bottom.
   2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

G. Phase, Neutral, and Ground Buses:
   1. Material: Tin-plated aluminum.
      a. Plating shall run entire length of bus.
      b. Bus shall be fully rated the entire length.
   2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
   3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
   4. Isolated Ground Bus (where noted on drawings): Adequate for branch-circuit isolated ground conductors; insulated from box. Where isolated ground transformers or feeders shown with isolated ground conductors on the one-line diagram.
   5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
   6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads. Rated 200 percent of full load current for K-factor rated transformers, and any transformer shown on the riser diagrams or one-line diagrams with 200% rated feeders.
   7. Split Bus: Vertical buses divided into individual vertical sections.

H. Conductor Connectors: Suitable for use with conductor material and sizes.
   1. Material: Tin-plated aluminum.
   2. Terminations shall allow use of 75 deg C rated conductors without derating.
   3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
   4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
   5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
   6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
   7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
   8. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

I. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
   1. Percentage of Future Space Capacity: Ten percent.

J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
   1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
   2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 POWER PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
   1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Mains: As indicated on drawings and schedules.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: As indicated on drawings and schedules.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. In the emergency distribution system(s), provide devices to selectively coordinate with all supply side overcurrent protective devices.

C. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers:
      a. Inverse time-current element for low-level overloads.
      b. Instantaneous magnetic trip element for short circuits.
      c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
   3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
   4. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
   5. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
   6. Subfeed Circuit Breakers: Vertically mounted.
   7. MCCB Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Breaker handle indicates tripped status.
      c. UL listed for reverse connection without restrictive line or load ratings.
      d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
      e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
      f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
      g. Shunt Trip (where identified on drawings or schedules): 24-V trip coil energized from separate circuit, set to trip at 70 percent of rated voltage.
      h. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
      i. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
      j. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
      k. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.5 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
   1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Handle Padlock Attachment: Handle attachment for 1, 2, or 3 pole breakers to lock breaker in ON or OFF position.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NECA 407.

C. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NECA 407.

D. Equipment Mounting:

1. Attach panelboard to the vertical finished or structural surface behind the panelboard.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Mount top of trim at a maximum of 90 inches (2286 mm) above finished floor unless otherwise indicated. Operating handle of top-most circuit breaker, in on position, shall not be higher than 79 inches (2000 mm) above finished floor or grade.

G. Mount panelboard cabinet plumb and rigid without distortion of box.

H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Mounting panelboards with space behind is recommended for damp, wet, or dirty locations. The steel slotted supports in the following paragraph provide an even mounting surface and the recommended space behind to prevent moisture or dirt collection.

J. Mount surface-mounted panelboards to steel slotted supports 5/8 inch (16 mm) in depth. Orient steel slotted supports vertically.

K. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

M. Install filler plates in unused spaces.

N. Stub four 1-inch (27-EMT) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-EMT) empty conduits into raised floor space or below slab not on grade.

O. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

P. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

D. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

G. Submit report to show emergency system(s) overcurrent devices selective coordination with all supply side overcurrent protective devices.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 262726
WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Straight-blade convenience, isolated-ground, and tamper-resistant receptacles.
2. USB charger devices.
3. GFCI receptacles.
4. Twist-locking receptacles.
5. Pendant cord-connector devices.
6. Toggle switches.
7. Wall plates.
8. Floor service outlets.
9. Poke-through assemblies.
10. Prefabricated multioutlet assemblies.
11. Service poles.

1.2 DEFINITIONS

A. Abbreviations of Manufacturers' Names:

1. Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.
2. Hubbell: Hubbell Incorporated: Wiring Devices-Kellems.
3. Leviton: Leviton Mfg. Company, Inc.
4. Pass & Seymour: Pass& Seymour/Legrand.

B. BAS: Building automation system.

C. EMI: Electromagnetic interference.

D. GFCI: Ground-fault circuit interrupter.

E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Provide coversheet indicating project title, project location, and vendor contact information.
2. Organize submittal into logical sections and provide table of contents.
3. Provide itemized bill of materials indicating model number and quantity for each product.
4. On datasheets with multiple products, indicate which product is provided under this project.
5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
6. Manufacturers' catalog sheets with complete technical data for each item being furnished.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Provide separate submittal directly to the Architect for approval of color and finishes of devices and plates. This submittal shall include all samples. Any devices submittal will be reviewed for technical performance only. Color and finishes must be approved by the project Architect.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Service/Power Poles: One for every 10, but no fewer than one.
   2. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
   3. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.

PART 2 PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
   1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
   2. Devices shall comply with the requirements in this Section.

D. Devices for Owner-Furnished Equipment:
   1. Receptacles: Match plug configurations.
   2. Cord and Plug Sets: Match equipment requirements.

E. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Eaton. (Arrow Hart is acceptable only where noted.)
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   3. Leviton Mfg. Company Inc. (Leviton).
   4. Pass & Seymour/Legrand (Pass & Seymour).

2.3 STRAIGHT-BLADE RECEPTACLES

A. Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton; 5361 (single), 5362 (duplex). (Arrow Hart AH5362)
      b. Hubbell; HBL5361 (single), HBL5352 (duplex).
      c. Leviton; 5361 (single), 5362 (duplex).
      d. Pass & Seymour; 5361 (single), 5362 (duplex).

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton; IG5362. (Arrow Hart IG5362)
      b. Hubbell; IG5362.
      c. Leviton; 5362IG.
      d. Pass & Seymour; IG5362.

2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.4 USB CHARGER DEVICES

A. Tamper-Resistant, USB Charger Receptacles: 12 V dc, 2.0 A, USB Type A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1310, and FS W-C-596.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton: TR7745 (15A), TR7746 (20A)
      b. Hubbell: USB15X2
      c. Leviton: T5630
      d. Pass & Seymour: TM8USB*CC6
   2. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
   3. USB Receptacles: Dual, Type A.
   4. Line Voltage Receptacles: Dual, two pole, three wire, and self-grounding.

2.5 GFCI RECEPTACLES

A. General Description:
   1. 2015 UL 943/CSA C22.2 No 144.1/ANCE NMX-J-250 Compliant.
   2. Self-testing, auto-monitoring with test-fail indication, with disconnection of power in case of test failure.
   3. Straight blade, feed-through type.
   4. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
   5. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton SGF20.
      b. Hubbell; GFRST20.
      c. Leviton; GFNT2.
      d. Pass & Seymour; 2097.

C. Tamper-Resistant GFCI Convenience Receptacles, 125 V, 20 A:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton TRSGF20
      b. Hubbell; GFTRST20.
      c. Leviton GFTR2
      d. Pass & Seymour; 1597TR.

2.6 PLUG-IN TYPE DEVICES

A. Equivalent devices to those listed above (receptacles) and below (switches) from the following manufactures in the series listed may be used instead of traditional wired devices.
   1. Eaton: ArrowLink Modular Wiring Devices.
   2. Hubbell: SNAPConnect Modular Wiring Devices.
   3. Leviton: Lev-Lok Modular Wiring Devices
   4. Pass & Seymour: PlugTail Modular Wiring Devices

B. Description:
   1. Device shall be plug connected, with a pigtail connector. The pigtail shall be connected to the building wiring. Provision shall be made for the pigtail connector to keep out construction debris including drywall compound, paint, and dust.

2. Device shall comply with all standards for traditional wired device and be equivalent grade and function as traditional wired device it replaces.

2.7 PLUG LOAD CONTROLLABLE RECEPTACLES

A. Equivalent devices to those listed above (receptacles) from the following manufactures in the series listed shall be used instead of traditional devices on circuits indicated with plug-load control.
   1. Eaton: N/A
   2. Hubbell: N/A
   3. Leviton: 5362-1P Half & 5362-2P Dual Controlled Receptacles
   4. Pass & Seymour: 5362CH Half & 5362CD Dual Controlled Receptacles

B. Description:
   1. Permanently marked controlled receptacle marking printed on the face of the device.

2.8 TWIST-LOCKING RECEPTACLES

A. Twist-Lock, Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton; CWL520R.
      b. Hubbell; HBL2310.
      c. Leviton; 2310.
      d. Pass & Seymour; L520-R.

B. Twist-Lock, Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A: comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton; IGL520R.
      b. Hubbell; IG2310.
      c. Leviton; 2310-IG.
      d. Pass & Seymour; IG4700.
   2. Description:
      a. Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
      b. Grounding: Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.9 PENDANT CORD-CONNECTOR DEVICES

A. Description:
   1. Matching, locking-type plug and receptacle body connector.
   2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
   3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
   4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.10 CORD AND PLUG SETS

A. Description:
   1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
   3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.11 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Single Pole:
      1) Eaton; AH1221.
      2) Hubbell; HBL1221.
      3) Leviton; 1221-2.
      4) Pass & Seymour; CSB20AC1.
   b. Two Pole:
      1) Eaton; AH1222.
      2) Hubbell; HBL1222.
      3) Leviton; 1222-2.
      4) Pass & Seymour; CSB20AC2.
   c. Three Way:
      1) Eaton; AH1223.
      2) Hubbell; HBL1223.
      3) Leviton; 1223-2.
      4) Pass & Seymour; CSB20AC3.
   d. Four Way:
      1) Eaton; AH1224.
      2) Hubbell; HBL1224.
      3) Leviton; 1224-2.
      4) Pass & Seymour; CSB20AC4.

C. Pilot-Light Switches, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Eaton; AH1221PL for 120 and 277 V.
   b. Hubbell; HBL1201PL for 120 and 277 V.
   c. Leviton; 1221-LH1.
   d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.
2. Description: Single pole, with LED-lighted handle, illuminated when switch is off.

2.12 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic; Match existing or color as selected by project designer.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.13 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Round, solid brass with satin finish.

D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

E. Voice and Data Communication Outlet: Blank cover with bushed cable opening.

2.14 POKE-THROUGH ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Hubbell Incorporated; Wiring Device-Kellems.
   2. Pass & Seymour/Legrand.
   3. Square D/Schneider Electric.
   4. Thomas & Betts Corporation.
   5. Wiremold/Legrand.

B. Description:
   1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
   2. Comply with UL 514 scrub water exclusion requirements.
   3. Service-Outlet Assembly: Flush type with two simplex receptacles and space for two RJ-45 jacks complying with requirements in Section 271500 "Communications Horizontal Cabling."
   4. Size: Selected to fit nominal 3-inch (75-mm) cored holes in floor and matched to floor thickness.
   5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
   6. Closure Plug: Arranged to close unused 3-inch (75-mm) cored openings and reestablish fire rating of floor.
   7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of two, four-pair cables that comply with requirements in Section 271500 "Communications Horizontal Cabling."

2.15 PREFABRICATED MULTIOUTLET ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Hubbell Incorporated; Wiring Device-Kellems.
   2. Wiremold/Legrand.

B. Description:
   1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
   2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

D. Multioutlet Harness:
   1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
   2. Receptacle Spacing: 12 inches (300 mm).
   3. Wiring: No. 12 AWG solid, Type THHN copper, two circuit, connecting alternating receptacles.

2.16 SERVICE POLES

A. Description:
   1. Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
   2. Poles: Nominal 2.5-inch- (65-mm-) square cross section, with height adequate to extend from floor to at least 6 inches (150 mm) above ceiling, and with separate channels for power wiring and voice and data communication cabling.
   3. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
   4. Finishes: Manufacturer's standard painted finish and trim combination.
   5. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, four-pair, Category 3 or Category 5 voice and data communication cables.
   6. Power Receptacles: Two duplex, 20-A, straight-blade receptacles complying with requirements in this Section.
   7. Data Communication Outlets: Blank insert with bushed cable opening.

2.17 FINISHES

A. Device Color:
   1. Wiring Devices Connected to Normal Power System: Match existing or as selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
   2. Wiring Devices Connected to Emergency Power System: Red.
   3. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:
   1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
   1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
      c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:
   1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
   4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
   5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
   6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
   7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
   8. Tighten unused terminal screws on the device.
   9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
   1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. 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.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

I. Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes and chases for rough-in of conduit and equipment, the contractor shall check with other contractors concerned, to determine exact field location of the above items. In addition, he shall check for exact direction of door swings so that local switches are properly located on the strike side.

J. Where more than one wiring device occurs in any one location, arrange devices in gangs with common cover plate, excluding wall box dimmers. Where ganged switches serving 277V lighting are served by different circuits, so as to result in the voltage between switches exceeding 300V, provide barriers in box per NEC Section 404-8(b).

K. In locations where several pieces of wall-mounted equipment such as wall switches and thermostats are in the same general area, all shall be installed and grouped in a neat, orderly fashion, all of the same horizontal or vertical center line, whichever the case may be. Variation from this direction shall be approved by the owner or the owner's representative. All receptacles and switches shall be mounted at a height as directed in drawings.

L. Install devices, accessories, and assemblies level, plumb, square with building lines, and secure.

M. Install GFCI type receptacles where located in bathrooms, kitchens, garages, outdoors, or within six feet of a water source.

N. Install GFCI type receptacles at all locations indicated as EWC (electric water cooler).

O. Install GFCI type receptacles at all locations for vending machines.

P. Install GFCI type receptacle with an in-use weatherproof cover for all receptacles indicated as weatherproof.

Q. Devices mounted in boxes which are not flush with the surface of the wall shall be installed so that the mounting yoke or strap of the device is held rigidly at the surface of the wall, but not supported by the wall. Provide washers or spacers to fill in the area between the box and the finished wall line.

R. Receptacles shall be installed so that the removal of the receptacle does not interrupt the continuity of the circuit.

S. Receptacles and switches shall have their device screws covered by two wraps of PVC electrical tape. Receptacles with integral hinged plastic covers meet this requirement.

T. For installations of multioutlet assemblies or service poles using multiple circuits, provide a multipole circuit breaker in panelboard for branch circuits.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.

C. Identify each receptacle with panelboard identification and circuit number. Use durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following tests and inspections:
   1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
   2. Test Instruments: Use instruments that comply with UL 1436.
   3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

D. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

E. Wiring device will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

SECTION 262813
FUSES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cartridge fuses rated 600 V ac and less for use in the following:
      a. Control circuits.
      b. Enclosed switches.
   2. Spare-fuse cabinets.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
   7. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
      a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
      b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
   8. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   9. Current-limitation curves for fuses with current-limiting characteristics.
   10. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software.
   11. Coordination charts and tables and related data.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," include the following:
   1. Ambient temperature adjustment information.
   2. Current-limitation curves for fuses with current-limiting characteristics.
   3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
   4. Coordination charts and tables and related data.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.5 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper Bussmann, Inc.
   2. Edison Fuse, Inc.
   3. Ferraz Shawmut, Inc.
   4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
   1. Type RK-1: 250 or 600-V, zero- to 600-A rating, 200 kAIC, time delay.
   2. Type RK-5: 250 or 600-V, zero- to 600-A rating, 200 kAIC, time delay.
   3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
   1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
   2. Finish: Gray, baked enamel.
   3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
   4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 USE APPLICATIONS

A. Cartridge Fuses:

1. Feeders: Class L, fast acting.
2. Motor Branch Circuits: Class RK1 or Class RK5, time delay.
3. Large Motor Branch (601-4000 A): Class L, time delay.
4. Control Circuits: Class CC, time delay, control transformer duty.
5. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Owner.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

SECTION 262816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Molded-case circuit breakers (MCCBs).
   4. Enclosures.

1.2 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Include wiring diagrams for power, signal, and control wiring.
   3. Provide coversheet indicating project title, project location, and vendor contact information.
   4. Organize submittal into logical sections and provide table of contents.
   5. Provide itemized bill of materials indicating model number and quantity for each product.
   6. On datasheets with multiple products, indicate which product is provided under this project.
   7. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   8. Manufacturers' catalog sheets with complete technical data for each item being furnished.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in electronic format.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Fuse Pullers: Two for each size and type.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
   2. Altitude: Not exceeding 6600 feet (2010 m).

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

2.2 FUSIBLE SWITCHES

A. In the emergency distribution system(s), provide devices to selectively coordinate with all supply side overcurrent protective devices.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. ABB Inc.
   2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   4. Siemens Energy & Automation, Inc.
   5. Square D; a brand of Schneider Electric.

C. Type HD, Heavy Duty:
   1. Single throw.
   2. Three pole.

3. 240 or 600-V ac.
4. 1200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24-V ac.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Hookstick Handle: Allows use of a hookstick to operate the handle.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 MOLDED-CASE CIRCUIT BREAKERS

A. In the emergency distribution system(s), provide devices to selectively coordinate with all supply side overcurrent protective devices.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

C. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

D. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

E. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated. MCCBs shall be equipped with a device for locking in the isolated position.

F. Lugs shall be suitable for 140 deg F (60 deg C) rated wire on 125-A circuit breakers and below.

G. Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.

H. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
   1. Instantaneous trip.
   2. Long- and short-time pickup levels.
   3. Long- and short-time time adjustments.
   4. Ground-fault pickup level, time delay, and I^2t response.

K. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
   3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
   4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).

C. Operating Mechanism: The circuit-breaker operating handle shall be directly operable through the front cover of the enclosure (NEMA 250 Type 1). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
   1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

3.4 INSTALLATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.5 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections for Switches:
   1. Visual and Mechanical Inspection:
      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, grounding, and clearances.
      c. Verify that the unit is clean.
      d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
      e. Verify that fuse sizes and types match the Specifications and Drawings.
      f. Verify that each fuse has adequate mechanical support and contact integrity.
      g. Inspect bolted electrical connections for high resistance using one of the two following methods:
         1) Use a low-resistance ohmmeter.
            (a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
         2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
            (a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
      h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
      i. Verify correct phase barrier installation.
      j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
   2. Electrical Tests:
      a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

C. Tests and Inspections for Molded Case Circuit Breakers:
1. Visual and Mechanical Inspection:
a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify that the unit is clean.
e. Operate the circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance using one of the two following methods:
1) Use a low-resistance ohmmeter.
(a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
(a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with the coordination study.
2. Electrical Tests:
a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
e. Determine the following by primary current injection:
1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Perform the following infrared scan tests and inspections and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
   c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.
   1. Test procedures used.
   2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
   3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

END OF SECTION

SECTION 262923
VARIABLE-FREQUENCY MOTOR CONTROLLERS (VFC'S)

PART 1 GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. Variable Frequency Motor Controller Bypass

C. VFC Filtering

D. Related Requirements:
   1. Section 260500 "Common Work Results for Electrical" for basic installation requirements.
   2. Section 260526 "Grounding and Bonding for Electrical Systems" for basic materials and installation of grounding.
   3. Section 262200 "Low-Voltage Transformers" for transformers to serve VFC's.
   4. Section 262813 "Fuses" for installation in VFC's and bypass units.
   5. Section 262816 "Enclosed Switches and Circuit Breakers" for disconnects and overcurrent protection of VFC's.

1.2 DEFINITIONS

A. CE: Conformite Europeene (European Compliance).

B. CPT: Control power transformer.

C. DDC: Direct digital control.

D. EMI: Electromagnetic interference.

E. LED: Light-emitting diode.

F. NC: Normally closed.

G. NO: Normally open.

H. OCPD: Overcurrent protective device.

I. PID: Control action, proportional plus integral plus derivative.

J. PWM: Pulse Width Modulation

K. RFI: Radio-frequency interference.

L. VFC: Variable-frequency motor controller.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.
   1. Include dimensions and finishes for VFCs.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
   7. Include mounting and attachment details.

8. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
9. Include diagrams for power, signal, and control wiring.
10. Detailed installation drawings including:
    a. Control terminals, designation, and locations
    b. Power circuit diagram identifying disconnects, bypass disconnect, filters or isolation transformer, and motor.
    c. Internal electrical wiring and control circuit diagram
    d. Wiring of auxiliary devices and optional inputs.
    e. Interconnection to harmonic filter traps, line reactors, and dV/dT filters.
11. Furnish a technical brochure or matrix detailing standard VFC features.
    a. Motor horse power and amperage rating.
    b. Power factor at full load.
    c. Input power characteristics.
    d. Full load Efficiency.
    e. Control interface requirements.
    f. Status display system.
    g. Options not listed in specifications.
12. Exceptions and variations from the specification.
13. Include steady state and fault current ratings.
14. Filter characteristics:
    a. Dimensional drawings with installed weight for each size.
    b. Power input characteristics.
    c. Wiring diagram

C. Contractor shall obtain all the VFC's from a single manufacturer for the entire Project. Coordinate between Division 23 prior to submitting shop drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
    1. Required working clearances and required area above and around VFCs.
    2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
    3. Show support locations, type of support, and weight on each support.
    4. Indicate field measurements.

B. Qualification Data: For testing agency.

C. Product Certificates: For each VFC from manufacturer.

D. Harmonic Analysis Report: Provide Project-specific calculations and manufacturer's statement of compliance with IEEE 519.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.
    1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
        a. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
        b. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

c. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Indicating Lights: Two of each type and color installed.
   4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
   5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Provide Variable Frequency Controllers suitable for operating with NEMA Design B induction motors. VFC's shall be compatible with standard 3 phase high efficiency motors.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
   1. VFC Warranty Period: Five years from date of Substantial Completion.
   2. Filter Warranty Period: Three years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Variable Frequency Motor Controller Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
   1. ABB Low-Voltage HVAC Drives
   2. Danfoss Inc; Danfoss Drives Div.

C. Harmonic Trap Filters, dV/dT, Filters, and Input Line Reactor Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   1. Trans Coil Inc.
   2. MTE

3. Myron Zucker
4. Schaffner

2.2 VFC SYSTEM DESCRIPTION AND RATINGS

A. General Requirements for VFCs:
   1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A.

B. Application: Constant torque or variable torque.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
   2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 66 Hz, with torque constant as speed changes; maximum voltage equals input voltage.

F. Unit Operating Requirements:
   1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
   2. Input AC Voltage Unbalance: Not exceeding 3 percent.
   3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
   4. Minimum Efficiency: 97 percent at 100 percent speed and greater than 80 percent at 50 percent speed.
   5. Minimum Power Factor: 95 percent at 100 percent speed and greater than 90 percent at 25 percent speed.
   6. Bus capacitance voltage ratings
      a. 208-240V VFC's shall have a minimum bus voltage capacitance of 400 VDC.
      b. 460-480V VFC's shall have a minimum bus voltage capacitance of 800 VDC.
   7. IGBT ratings
      a. 208-240V VFC's shall be equipped with IGBT's that have a minimum V_{ce} rating of 600V.
      b. 460-480V VFC's shall be equipped with IGBT's that have a minimum V_{ce} rating of 1200V.
   8. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
   9. Ambient Temperature Rating: Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C).
   10. Humidity Rating: Less than 95 percent (noncondensing).
   11. Altitude Rating: Not exceeding 3300 feet (1000 m).
   12. Audible noise shall not exceed 85 dBa measured at a point 3 feet from the VFC.
   13. Vibration Withstand: Comply with NEMA ICS 61800-2.
   14. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
   15. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
   16. Speed Regulation: Plus or minus 10 percent.
   17. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
   18. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Converter Section
    1. Utilize six-pulse full wave diode or PWM bridge design to convert fixed voltage and frequency AC line power to fixed DC voltage.
    2. Operation of the converter section shall be unaffected by phase rotation.
    3. Input shall have MOVs (Metal Oxide Varistors) for surge protection.

H. DC Bus Section
    1. DC bus shall include a minimum 5% integrated DC link reactors to minimize harmonic distortion.
    2. DC bus shall have a passive capacitive filter to minimize ripple and maximize power-loss ride through.
    3. Provide balance discharge resistors to equalize charge voltage and permit safe discharge of capacitors upon loss of power.

I. Inverter Section
    1. Utilize isolated-gate bipolar transistors (IGBTs) to convert DC bus voltage to tree phase, variable frequency, and sinusoidal coded PWM waveform to control the motor. Six step and current source drives are not acceptable.
    2. PWM switching frequencies (Carrier Frequency): Selectable; 1.0 to 12 kHz. Factor set the carrier frequency at 3 kHz.
    3. VFC shall be capable of skipping over minimum of [two] critical frequencies to prevent the VFC from operating the load continuously at unstable speeds. VFC shall accelerate or decelerate through these ranges, but not be allowed to operate consistently in these ranges.

J. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

K. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
    1. Signal: Electrical.

L. Internal Adjustability Capabilities:
    1. Minimum Speed: 5 to 25 percent of maximum rpm.
    2. Maximum Speed: 80 to 100 percent of maximum rpm.
    3. Acceleration: 0.1 to 999.9 seconds.
    4. Deceleration: 0.1 to 999.9 seconds.
    5. Current Limit: 30 to minimum of 150 percent of maximum rating.

M. Self-Protection and Reliability Features:
    1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
    2. Surge Suppression: Field-mounted surge suppressors complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits," UL 1449 SPD, Type 2.
    3. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
    4. Under- and overvoltage trips.
    5. Inverter overcurrent trips.
    6. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
    7. Critical frequency rejection, with [three] <Insert number> selectable, adjustable deadbands.
    8. Instantaneous line-to-line and line-to-ground overcurrent trips.
    9. Loss-of-phase protection.
    10. Reverse-phase protection.
    11. Short-circuit protection.
    12. Motor-overtemperature fault.

N. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

O. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

P. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

Q. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

R. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

2.3 PERFORMANCE REQUIREMENTS

A. If audible motor noise created by the VFC exceeds [5] dB of the motor noise generated when the motor is directly connected to line power through an across the line starter, the VFC supplier shall remedy the situation at no cost.

2.4 CONTROLS AND INDICATION

A. Electrically isolate the following circuit systems from the main power circuits:
   1. Internal control circuiting regulating DC bus voltage and inverter output frequency.
   2. Circuitry supplying various microprocessors, controllers, sensors, etc., which provide the VFC's operational and safety features.

B. Provide devices which will limit the following operational parameters:
   1. Permit field adjustment of minimum and maximum output frequency. The range shall be adjustable from 4 Hz to 60 Hz.
   2. Permit field adjustment of the acceleration rate intervals from 0% to 100% speed. Unless noted otherwise, set full range acceleration rates initially at 60 seconds.
   3. Permit field adjustment of the deceleration rate intervals from 0% to 100% speed. Unless noted otherwise, set full range deceleration rate at 60 seconds.

C. Status Lights: Door-mounted LED indicators displaying the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.
   5. Overcurrent.
   6. External fault.

D. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
   1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
   2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
      a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

E. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

F. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
   1. Output frequency (Hz).
   2. Motor speed (rpm).
   3. Motor status (running, stop, fault).
   4. Motor current (amperes).
   5. Motor torque (percent).

6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).
11. Heat sink temperature
12. Operating hours (with reset function)
13. Megawatt hours (with reset function)

G. VFC Monitoring and Alarming

1. The VFC controller shall have the ability to display the following alarms and notifications at the VFC display as well as the relay the to the building automation system via communications interface.
   a. Status indicators
      1) On/Off status
      2) Input power Status
      3) Input power fault
      4) Over-current fault
      5) Ground fault
      6) Under-voltage
      7) Over-voltage
      8) Over-temperature fault
      9) Motor over-load fault
      10) Motor under-load fault
      11) DC braking
      12) Emergency off
      13) Retry
      14) Restart

   b. Alarms
      1) Over-voltage pre-alarm
      2) Over-current pre-alarm
      3) Under-voltage
      4) Overheat pre-alarm
      5) Overload pre-alarm
      6) Communications Error
      7) Tuning Error
      8) Point setting alarm
      9) Clear enabling indication
      10) Emergency Stop Enabling indication
      11) Setting Error Alarm
      12) Momentary power loss slowdown
      13) Lower-limit time-out stop
      14) VFD in bypass

   c. Faults
      1) Over-current (start up)
      2) Over-current (Acceleration, Deceleration, and Running)
      3) U-phase short
      4) V-phase short
      5) W-phase short
      6) Over-voltage (Acceleration, Deceleration, and Running)
      7) Under-voltage
      8) Over-frequency
      9) Under-frequency
      10) Over-heat
      11) Over-heat (external)
      12) Over-torque
      13) Inverter overload
      14) Motor overload

15) Ground Fault
16) Input phase failure
17) Output phase failure
18) Sequence error
19) Speed error
20) V/Hz control error
21) Communications error
22) Logic voltage error
23) Self-diagnostics alarm
24) VFD in bypass

d. VFC shall be equipped of automatic reset and restart circuit which will restart the motor 20 seconds after self-protection shut down. The VFC shall attempt no more than 5 automatic restarts. Each successive attempt shall occur at least 120 seconds after the last.

H. Control Signal Interfaces (I/O):
1. Electric Input Signal Interface:
   a. A minimum of [two] <Insert number> programmable analog inputs: [0- to 10-V dc] [4- to 20-mA dc] [Operator-selectable "x"- to "y"-mA dc] <Insert signal parameters>.
   b. A minimum of [six] <Insert number> multifunction programmable digital inputs.
2. Pneumatic Input Signal Interface: 3 to 15 psig (20 to 104 kPa).
3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
   a. 0- to 10-V dc.
   b. 4- to 20-mA dc.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
4. VFC shall be equipped with a 120 VAC or 24 VDC safety circuit for fire alarm system shutdown.
5. Output Signal Interface: A minimum of one programmable analog output signal(s) (4- to 20-mA dc), which can be configured for any of the following:
   a. Output frequency (Hz).
   b. Output current (load).
   c. DC-link voltage (V dc).
   d. Motor torque (percent).
   e. Motor speed (rpm).
   f. Set point frequency (Hz).
   g. <Insert indication>.
6. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
   a. Motor running.
   b. Set point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.

I. Communications Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.
1. Hardwired Points:
   a. Monitoring: On-off status.
   b. Control: On-off operation.
2. Communication Interface: Comply with [ASHRAE 135] <Insert type of interface>. Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the DDC system for HVAC.
   a. Coordinate with Division 23 and provide signal compatibility for a direct serial communications interface with:
      1) Verify existing control system in existing building.

2.5 LINE CONDITIONING AND FILTERING

A. Provide UL listed Filters for the application.

B. Filters shall be located adjacent to the VFC or contained in a common enclosure as the VFC it is serving.

C. Filter enclosures shall be meet the same requirements as specified for VFC's.

D. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

E. Input Line Conditioning
   1. Provide a 5% input line reactor on the input of all VFC's greater than 50 HP in addition to any internal line reactors and filters.
   2. Provide harmonic filters on the input of all VFC's serving motors greater than 50 HP
      a. Provide contactor within filter to disconnect capacitors from line power to the VFC when signal is received from the VFC. VFC shall be programed to disconnect capacitors at 25% load and energize capacitors at 30% load.
      b. Provide contactor to bypass entire filter when VFD has been bypassed. Provide interlock between bypass switch and contactor.
   3. VFC disconnecting means shall disconnect power to input filter and reactors.

F. Output Filtering: Provide dV/dT filters for all locations where conductors between the motors and VFC are [75] feet or longer.

G. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.6 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
   1. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.

B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.

C. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.
   1. Bypass Contactor: Load-break, NEMA-rated contactor.
   2. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
   3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration: Full-voltage (across-the-line) for motors less than 40 HP, Reduced-voltage (autotransformer) for motors 40 HP and larger type.
   1. NORMAL/BYPASS selector switch.
   2. HAND/OFF/AUTO selector switch.
   3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
   4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.
      a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
      b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
   5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
      a. CPT Spare Capacity: 50 VA.

6. Overload Relays: NEMA ICS 2.
    a. Solid-State Overload Relays:
        1) Switch or dial selectable for motor-running overload protection.
        2) Sensors in each phase.
        3) Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
        4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
        5) Analog communication module.
    b. NC isolated overload alarm contact.
    c. External overload, reset push button.

2.7 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
    1. Dry and Clean Indoor Locations: Type 1.
    2. Outdoor Locations: Type 3R.
    3. Kitchen and Wash-Down]Areas: Type 4X, stainless steel.
    4. Other Wet or Damp Indoor Locations: Type 4.
    5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

C. Internal cooling fans and filers shall be provided where required to maintain drive operating temperature.

D. Internal heating elements shall be provided where required to maintain drive operating temperature.

E. Provide lifting provisions for units weighing more than 80 pounds.

F. All units shall be provided with a grounding lug.

G. The enclosure shall have a through-the-door interlocking handle with padlocking provisions.

H. Wall units shall be provided with necessary mounting brackets.

2.8 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
    1. Push Buttons: Shielded.
    2. Pilot Lights: Push to test.
    3. Selector Switches: Rotary type.
    4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. Reversible NC/NO bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
    1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Digital Meters:
    1. Elapsed-time meter.
    2. Kilowatt meter.
    3. Kilowatt-hour meter.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

2.9 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
   1. Test each VFC while connected to its specified motor.
   2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 COORDINATION

A. The VFC manufacturer shall obtain information about any critical speeds, which must be locked out in the VFC controls to avoid noise and vibration caused by harmonic resonance in the mechanical system.

B. Contractor shall coordinate final VFC locations with VFC manufacturer and mechanical equipment layouts.

3.3 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Floor-Mounting Controllers: Install VFCs on 4-inch (100-mm) nominal thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete" or Section 033053 "Miscellaneous Cast-in-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.
   1. Curbs and roof penetrations are specified in Section 077200 "Roof Accessories."

2. Structural-steel channels are specified in Section 260529 "Hangers and Supports for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Separate line, load, and control conductors in separate continuous metallic conduits. Provide ferrous metallic shielding around each VFC conductor group when conductors are installed in wire way or gutter. The contractor may submit shielded conductor cable assemblies designed for operation with VFC's.

F. Provide all power connection including wiring associated with any isolation transformer disconnect reactors, filters, and any accessories. Include power wiring from the VFC to the motor, as well as all grounding connections.

G. Where it is not possible to install motors within the sight of the VFC provide a disconnect switch at the motor as required by the NEC or required by the specifications. Provide an interlocking connection between the disconnect at the motor and the VFC to prevent the VFC from operating in a no load situation

H. All connections to the VFC shall be with a minimum 18 inches of seal tight flexible conduit, allowing for ease of maintenance.

I. Provide separate grounding conductor to the VFC and between the VFC and the motor in addition to the conduit system.

J. Temperature control contractor shall provide all control connections to the VFC from any sensors or control devices.

K. Provide separate overload protection for each motor when a VFC serve multiple motors.

L. Install fuses in each fusible-switch VFC.

M. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

N. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

O. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

P. Comply with NECA 1.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
   2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.5 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each VFC with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
   2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
   3. Test continuity of each circuit.
   4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
   5. Test each motor for proper phase rotation.
   6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
      c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
   10. Test voltage distortion. Voltage distortion shall not exceed 3% and the line notch depth shall not exceed 10% as defined in IEEE Standard 519-1992 “IEEE Guide for Harmonic control and Reactive Compensation of Static Power Converters.” Provide necessary harmonic filters or line reactors to achieve these values. A written report shall be provided to the engineer showing all test results.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. At a minimum perform the following operational checks and provide a report to the engineer that each VFC has met the following checks:
      a. Maximum output frequency = 60 Hz ± 1 Hz.
      b. Minimum output frequency = 4 Hz ± 1 Hz.
      c. Control signal setpoint ± 10% of that specified.
      d. Simulated power outage and control system reaction.
      e. Manual bypass switchover and operation tested.
      f. Starting into an already rotating motor load and determine if self-protection of the VFC is adequate.

g. Acceleration rate from a dead stop to full speed at the maximum and minimum rate adjustment.
h. Deceleration rate from full speed to dead stop at maximum and minimum rate adjustment.

3.8 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

F. Set field-adjustable pressure switches.

3.9 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs. The manufacturer shall arrange for and conduct a user training session(s) at the Project site, explaining the operation of each type of VFC package. Allow for a minimum 4 hours of training for the first VFC and 1 hours of training for each additional VFC up to a maximum of 15 hours. The supplier shall notify the Engineer of the training session at least 1 week prior to the scheduled date so the Engineer can make arrangement to attend.

END OF SECTION

SECTION 265119
LED INTERIOR LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interior solid-state luminaires that use LED technology.
   2. Lighting fixture supports.

B. Related Requirements:
   1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
   2. Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
   7. Arrange in order of luminaire designation.
   8. Include data on features, accessories, and finishes.
   9. Include physical description and dimensions of luminaires.
   10. Include emergency lighting units, including batteries and chargers.
   11. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
   12. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project IES LM-79 and IES LM-80.
       a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
       b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
       c. Provide certification of one of the following:
          1) LM-79-08 report at T=0 and at T=6000 hours with a summary table showing the percent lumen output change and percent input power change.

2) LM-80-08 test data for the LEDs at the three temperatures per LM-80-08. Provide extrapolation data using an exponential decay function to show the output at 50,000 hours. Provide the Ts value from the LM-79-08 and where the point falls in relation to the LM-80-08 extrapolated data. Interpolate between the LM-80-08 data for the T_s temperature.

B. Shop Drawings: For nonstandard or custom luminaires.
   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Certificates: For each type of luminaire.

D. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

E. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. LEDs: Provide One for every 100 factory assembled replacement LED package with electrical leads. Furnish at least one of each type. May be unitized with power supply unit/driver.
   2. Power Supply Units/ driver: One for every 100 of each type and rating installed. Furnish at least one of each type. May be unitized with LEDs.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period for Light Sources: Five year replacement material warranty on all light sources (LED package, LED array, or LED module) including, but not limited to the LED die, encapsulate, and phosphor for the LEDs lumen maintenance not achieving L_{70} after 75,000 hours.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by UL, ETL, CSA, or other qualified testing agency, and marked for intended location and application.

B. Standards:
   1. ENERGY STAR certified.
   2. California Title 24 compliant.
   3. DLC Certified.
   4. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
   5. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
   6. UL Listing: Listed for damp location.
   7. Recessed luminaires shall comply with NEMA LE 4.
   8. User Replaceable Lamps:
      a. Bulb shape complying with ANSI C78.79.
      b. Lamp base complying with ANSI C81.61 or IEC 60061-1.

C. CRI of minimum 70. CCT of 3500K.

D. Rated lamp life of 75,000 hours.

E. Lamps dimmable from 100 percent to 1 percent of maximum light output.

F. Internal driver.

G. Nominal Operating Voltage: As scheduled.

2.3 LEDS

A. LED sources must meet the following requirements:
   1. Operating temperature rating must be between -40°C and +50°C
   2. Correlated Color Temperature (CCT):
      a. Nominal CCT: 3500 K (3465 ± 245)
      b. Du'v' tolerance of 0.001 ± 0.006
   3. Color Rendering Index (CRI): greater than or equal to 80.
   4. Luminaire manufacturer must submit reliability reports indicating that the manufacturer of the LED (chip, diode, or package) has performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows:
      a. High Temperature Operating Life (HTOL)
      b. Room Temperature Operating Life (RTOL)
      c. Low Temperature Operating Life (LTOL)
      d. Powered Temperature Cycle (PTMCL)
      e. Non-Operating Thermal Shock (TMSK)
      f. Mechanical Shock
      g. Variable Vibration Frequency
      h. Solder Heat Resistance (SHR)

2.4 LED DRIVERS / POWER SUPPLYS

A. LED drivers must meet the following requirements:
   1. Drivers must have a minimum efficiency of 85%.
   2. Starting Temperature: -40° C.
   3. Electrical Characteristics.
      a. Volts: as indicated on Luminaire Schedule.
      b. Phase: Single.
      c. Hertz: 60.
   4. Power supplies can be UL Class I or II output.
   5. Drivers must have a Power Factor (PF) of greater than or equal to 0.90.
   6. Drivers must have a Total Harmonic Distortion (THD) of less than or equal to 20%.
   7. Drivers must comply with FCC 47 CFR Part 15 non-consumer RFI/EMI standards.
   8. Drivers must be Reduction of Hazardous Substances (RoHS) compliant.
   9. Inrush current <2A
   10. Sound rating: Inaudible in a 24 dB ambient.
   11. Class P thermally protected.

2.5 LED LUMINAIRES

A. Provide luminaires with integral LED thermal management system (heat sinking).

B. Luminaires shall be equipped with an LED driver that accepts 120V through 277V, 50hz to 60hz (UNIV). Component-to-component wiring within the luminaire will carry no more than 80% of rated current and be listed by UL for use at 600 VAC at 302°F/150°C or higher. Plug disconnects shall be listed by UL for use at 600 VAC, 15A or higher.

C. LED modules shall have a minimum L70 service life of 75,000 hours at 25°C ambient temperature and based on IESNA LM-80 methodology.

D. Provide luminaires with individual LED arrays/ modules and drivers that are accessible and replaceable from exposed side of the luminaire. Luminaires requiring removal or replacement of entire luminaire to access LEDs and drivers will NOT be accepted.

E. Luminaire efficiency shall be minimum of 100 lumens per watt.

F. Warranty: 5 year warranty covering the LED arrays, and LED drivers.

G. Continuous Flicker Free dimming range 100% to 1% measured relative light output.

2.6 MATERIALS

A. Metal Parts:
   1. Free of burrs and sharp corners and edges.
   2. Sheet metal components shall be steel unless otherwise indicated.
   3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:
   1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   2. Glass: Annealed crystal glass unless otherwise indicated.
   3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

D. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. Lamp diameter, shape, size, wattage, and coating.
      c. CCT and CRI for all luminaires.

2.7 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.8 LUMINAIRE SUPPORT

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting not to exceed 2,500 hours of use for LED luminaries. When construction is sufficiently complete, clean luminaires used for temporary lighting.

3.3 INSTALLATION

A. Comply with NECA/IESNA-500, “Recommended Practice for Installing Indoor Commercial Lighting Systems.”

B. Comply with NECA 1.

C. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

D. Install lamps in each luminaire.

E. Supports:
   1. Sized and rated for luminaire weight.
   2. Able to maintain luminaire position after cleaning and relamping.
   3. Provide support for luminaire without causing deflection of ceiling or wall.
   4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

F. Flush-Mounted Luminaire Support:
   1. Secured to outlet box.
   2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
   3. Trim ring flush with finished surface.

G. Wall-Mounted Luminaire Support:
   1. Attached to a minimum 20 gauge backing plate attached to wall structural members.
   2. Do not attach luminaires directly to gypsum board.

H. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 120 inches (6 m) in length.

I. Suspended Luminaire Support:
   1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
   2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
   3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
   4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

J. Ceiling-Grid-Mounted Luminaires:
   1. Secure to any required outlet box.
   2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
   3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

L. Light Track: Support track on maximum of 4 foot centers.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
   2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

D. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

E. Advance Notice: Give dates and times for field tests.

F. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

G. Corroded Fixtures: Replace during warranty period.

3.6 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 260923 "Lighting Control Devices."

B. Clean luminaires internally and externally after installation. Use methods and materials recommended by manufacturer.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

B. During adjustment visits, inspect all luminaires. Replace luminaires that are defective.

C. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

D. Adjust the aim of luminaires in the presence of the Architect.

E. Adjust aimable luminaires according to the directions shown on lighting drawings or per Owner’s direction.

3.8 INTERIOR LUMINAIRE SCHEDULE

A. See drawings for Luminaire Schedule.

END OF SECTION

SECTION 265219
EMERGENCY AND EXIT LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Emergency lighting units.
   2. Exit signs.
   3. Luminaire supports.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Fixture: See "Luminaire" Paragraph.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
   7. Include data on features, accessories, and finishes.
   8. Include physical description of the unit and dimensions.
   9. Battery and charger for light units.
   10. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
   11. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
      a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Product Schedule:
   1. For emergency lighting units. Use same designations indicated on Drawings.
   2. For exit signs. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Product Certificates: For each type of luminaire.

C. Product Test Reports: For each luminaire for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Emergency Power Unit Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining four years.
   2. Warranty Period for Emergency Fluorescent Ballast Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining six years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

C. Comply with NFPA 70 and NFPA 101.

D. Comply with NEMA LE 4 for recessed luminaires.

E. Comply with UL 1598 for fluorescent luminaires.

F. Lamp Base: Comply with ANSI C81.61 or IEC 60061-1.

G. Bulb Shape: Complying with ANSI C79.1.

H. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast.

1. Emergency Connection: Operate one lamp(s) continuously at an output of 1100 lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    a. Ambient Temperature: Less than 0 deg F (minus 18 deg C) or exceeding 104 deg F (40 deg C), with an average value exceeding 95 deg F (35 deg C) over a 24-hour period.
    b. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C).
    c. Humidity: More than 95 percent (condensing).
    d. Altitude: Exceeding 3300 feet (1000 m).
4. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
5. Battery: Sealed, maintenance-free, lead-acid type.
6. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

I. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.
1. Emergency Connection: Operate one LED lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire driver.
2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
3. Nightlight Connection: Operate lamp in a remote luminaire continuously.
4. Battery: Sealed, maintenance-free, lead-acid type.
5. Charger: Fully automatic, solid-state, constant-current type.
6. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the distance recommended by the emergency power unit manufacturer, whichever is less.
7. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
8. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.3 EMERGENCY LIGHTING

A. General Requirements for Emergency Lighting Units: Self-contained units.
1. Emergency Luminaires: As indicated on Interior Lighting Fixture Schedule, with the following additional features:
    a. Operating at nominal voltage of 120 V/277 V ac.
    b. Internal emergency power unit.
    c. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.

B. Emergency Lighting Unit:
1. Emergency Lighting Unit: As indicated on Interior Lighting Fixture Schedule.

2. Operating at nominal voltage of 120/277 V ac.
3. Wall with universal junction box adaptor.
4. UV stable thermoplastic housing, rated for damp locations.
5. Two LED lamp heads.
6. Internal emergency power unit.

C. Remote Emergency Lighting Units:

1. Emergency Lighting Unit: As indicated on Interior Lighting Fixture Schedule.
2. Wall with universal junction box adaptor.
3. UV stable thermoplastic housing, rated for damp locations.
4. One LED lamp heads.
5. External emergency power unit.

2.4 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Operating at nominal voltage of 120/277 V ac.
2. LEC (Light Emitting Capacitor): Solid state panel type, 3/8 watt power draw for single face, non-battery unit, universal input power.
3. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
4. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
5. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
   a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Battery: Sealed, maintenance-free, nickel-cadmium type.
7. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

C. Self-Luminous Signs:

1. Powered by tritium gas, with universal bracket for flush-ceiling, wall, or end mounting. Signs shall be guaranteed by manufacturer to maintain the minimum brightness requirements in UL 924 for 15 years.
2. Use strontium oxide aluminate compound to store ambient light and release the stored energy when the light is removed. Include universal bracket for flush-ceiling, wall, or end mounting.

2.5 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
4. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
5. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

2.6 METAL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA/IESNA-500, “Recommended Practice for Installing Indoor Commercial Lighting Systems.”

B. Comply with NECA 1.

C. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

D. Install lamps in each luminaire.

E. Supports:
   1. Sized and rated for luminaire and emergency power unit weight.
   2. Able to maintain luminaire position when testing emergency power unit.
   3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
   4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:
   1. Attached to a minimum 20-gage backing plate attached to wall structural members.
   2. Do not attach luminaires directly to gypsum board.

G. Ceiling Grid Mounted Luminaires:
   1. Secure to any required outlet box.
   2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
   3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

D. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

E. Advance Notice: Give dates and times for field tests.

F. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

G. Corroded Fixtures: Replace during warranty period.

3.5 STARTUP SERVICE

A. Perform startup service:
   1. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
   1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.
      a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
   2. Conduct short-duration tests on all emergency lighting.

B. Adjust aimable luminaires according to the directions shown on lighting drawings or per Owner’s direction.

3.7 CLEANING

A. Clean luminaires internally and externally after installation. Use methods and materials recommended by manufacturer.

3.8 INTERIOR LUMINAIRE SCHEDULE

A. See drawings for Luminaire Schedule.

END OF SECTION

SECTION 270500
COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Communications equipment coordination and installation.
   2. Common communications installation requirements.
   3. Demolition.
   4. Cutting and patching for electrical construction.
   5. Touchup painting.
   6. Disposition of existing materials and equipment.
   7. Communication Service Outage and Energizations.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Comply with State and /or City Code requirements.

D. All materials shall meet the standards of the following institutes where applicable:
   1. National Fire Protection Association (NFPA)
   2. American Society of Testing Materials (ASTM)
   3. American National Standards Institute (ANSI)
   4. National Electrical Manufacturer's Association (NEMA)
   5. Institute of Electrical and Electronic Engineers (IEEE)

1.3 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Section 083100 "Access Doors and Panels."

D. Coordinate chases, slots, inserts, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
   1. Core drilling through post-tensioned slab: The existing post-tensioned slabs contain post-tensioned tendons that must not be damaged or broken. No nailing, drilling, cutting or other disruption to the slab is allowed without prior written approval by the structural engineer. Contractor shall positively locate the existing tendons and submit to the structural engineer for approval a written procedure, including plans showing existing tendon locations and proposed disruption of the slab.

E. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

F. Coordinate communication service connections to components furnished by utility companies.

1. Coordinate installation and connection of exterior underground and overhead utilities and services.

G. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability. Document results of said testing.

1.4 DRAWINGS

A. The drawings indicate the arrangements of electrical equipment. Review architectural drawings and details for door swings, cabinets, counters and built-in equipment; conditions indicated on architectural plans shall govern. Coordinate installation of electrical equipment with structural system and mechanical equipment and access thereto. Coordinate installation of recessed electrical equipment with concealed ductwork and piping, and wall thickness. All devices, raceway, and electrical equipment in finished and/or public spaces shall be recessed or concealed unless otherwise noted.

B. Do not scale drawings. Obtain dimensions for layout of equipment from Architectural plans and details unless indicated on Electrical plans.

C. Bring discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Architect.

D. Equipment layout is based on one manufacturer's product or from composite dimensions from multiple manufacturers. Where equipment selected for use on the job differs from layout, coordinate space requirements and connection arrangements.

1.5 SITE INVESTIGATION

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions which may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original condition, with the exception of the work under this contract, before the completion of this project. Existing systems and conditions which are not detailed on the drawings must still be restored to their original condition.

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

3.2 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section 078400 "Firestopping."

3.3 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Reroute communication cables as required to serve equipment not in the demolition area.

C. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

D. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

E. Remove demolished material from Project site.

F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

G. Remove devices on wall or ceilings being removed. Coordinate with other divisions.

H. Assume that existing equipment and fittings indicated to be reused are in good working condition and can be installed without repairs. Notify the Architect of items found to be in need of repair or in unusable condition for direction or decision. Repair any damage to equipment caused in removal or handling

I. Fittings and other equipment removed and to be-used shall be cleaned before reinstallation.

J. Added Cables: All cables added shall be coordinated with existing to remain. Where additional cables are added, identify cables per the system as exists in the facility.

K. All material and equipment which is noted or required by the owner to be salvaged and which is not scheduled to be reused or relocated shall be carefully removed and shall be delivered to the owner and stored where directed on the site.

L. Remove abandoned low voltage wiring. All wiring disconnected on one or both ends is considered abandoned unless tagged and labeled “future” or “spare”. Verify with Owner any cabling connected on both ends is still in use prior to removal.

3.4 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.5 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Firestopping.
2. Electrical demolition.
3. Cutting and patching for electrical construction.
4. Touchup painting.

3.6 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Section 099000 "Painting."

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the

degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.7 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

3.8 COMMUNICATIONS SERVICE OUTAGE AND ENERGIZATIONS

A. Owner Approval: Communications service outages or energizations required shall be approved by the Owner before outages or energization. Outages shall be scheduled at the convenience of the Owner.

B. Written Request: Requests for outages and energizations shall be submitted in writing to the Owner for approval at the earliest possible date and in no case later than 14 days prior to the outage and/or energization.

C. Cancellation: The Owner reserves the right to cancel or change the scheduling of any outage up to 24 hours before its approved starting time. There shall be no additional cost to Owner for scheduled outages, or for outages re-scheduled at the Owner's request where at least 24 hours notice has been given by the Owner.

D. Schedules: A minimum of two (2) weeks before the first outage, submit a schedule of proposed sequence of the communications services outages and energizations. This schedule shall show construction energizations and shall include any weekend work. The schedule shall list the work to be completed during and between each outage.

E. Minimize outages on the Owner's communications systems and employ sufficient workmen so that work will be carried on concurrently at more than one location, when necessary.

F. Before submitting any energization and/or outage requests, provide the owner with evidence that the following requirements have been met:
   1. All required equipment and material is on the job site. All related installations that can be worked on without an energization and/or outage are complete, tested, available for inspection, and ready for service.
   2. All shop drawings, test reports, installation data, and operational data have been submitted and approved.
   3. The energizing and outage schedule has been submitted and approved.

END OF SECTION

SECTION 270513
COMMUNICATIONS SERVICES

PART 1 GENERAL

1.1 DESCRIPTION

A. This section includes the complete interior and exterior technology systems as indicated on the drawings or as specified herein. Provide materials, labor, equipment and supervision to install technology systems.

B. Codes and standards determine requirements. Contract documents and manufacturer warrantee requirements that exceed the codes and standards are the responsibility of the installing contractor.

1.2 QUALITY ASSURANCE

A. Technology work shall be in accordance with the following codes and agencies. Refer to the most recent adopted version.
   1. National Electrical Code (ANSI/NFPA 70).
   2. National Electrical Safety Code (ANSI C-2).
   3. Life Safety Code (NFPA 101).
   4. Occupation Safety and Health Administration (OSHA).
   5. State and Municipal ordinances.
   6. Americans with Disabilities Act (ADA).
   7. International Building Code (IBC).
   8. International Conference of Building Officials (ICBO).

B. Material and Installation Standards: Provide new material and conform to the standards where such have been established for the particular material and installation in question. Publications and Standards of the organization listed below are applicable to materials and installation specified herein. Refer to the most recent adopted version.
   1. American Society for Testing and Materials (ASTM)
   2. Underwriters' Laboratories, Inc. (UL)
   3. National Electrical Manufacturer Association (NEMA)
   4. Insulated Cable Engineers Association (ICEA)
   5. Institute of Electrical and Electronic Engineers (IEEE)
   6. National Fire Protection Association (NFPA)
   7. American National Standards Institute (ANSI)
   8. Electrical Testing Laboratory (ETL)
   9. Edison Electric Institute (EEI)
   10. National Board of Fire Underwriters (NBFU)
   11. International Standards Organization (ISO)
   12. Federal Communications Commission (FCC)
   13. ANSI/TIA/EIA-526 – Standard Test Procedures for Fiber Optic Systems.
   14. TIA/EIA-526-7-A – Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fiber-Optic Communications Subsystem Test Procedures – Part 4-2: Installed Cable Plant – Single-mode Attenuation and Optical Return Loss Measurement.
   15. TIA/EIA-526-14-C – Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; Modification of IEC 61280-4-1 edition 2, Fiber-Optic Communications Subsystem Test Procedure - Part 4-1: Installed cable plant - Multimode attenuation measurement.
   16. ANSI/TIA-568.0-D – Generic Telecommunications Cabling for Customer Premises.
   17. ANSI/TIA-568.1-D – Commercial Building Telecommunications Cabling Standard.
   18. ANSI/TIA-568-C.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
   19. ANSI/TIA-568-C.3 – Optical Fiber Cabling Components Standard.
   20. ANSI/TIA-568-C.4 – Broadband Coaxial Cabling and Components Standard.
   21. ANSI/TIA/EIA-569-D – Telecommunications Pathways and Spaces.
   22. ANSI/TIA/EIA-570-C – Residential Telecommunications Infrastructure Standard.
   23. ANSI/TIA/EIA-598-D – Optical Fiber Cable Color Coding.

24. ANSI/TIA/EIA-606-B – Administration Standard for the Commercial Telecommunications Infrastructure.
25. ANSI/TIA-607-B – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
26. ANSI/TIA/EIA-758-B – Customer-Owned Outside Plant Telecommunications Infrastructure Standard.
27. ANSI/TIA-942-A – Telecommunications Infrastructure Standard for Data Centers.
28. ANSI/TIA-1152 – Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling.
29. FIPS PUB 174 – Federal Building Telecommunications Wiring Standard.
30. FIPS PUB 175 – Federal Building Standard for Telecommunications Pathways and Spaces.
31. FIPS PUB 176 – Residential and Light Commercial Telecommunications Wiring Standard.
32. ISO/IEC 11801 – Information Technology – Generic Cabling for Customer Premises.
33. TIA/EIA IS-729 – Technical Specifications for 100 Ohm Screened Twisted-Pair Cabling.
34. ANSI/NECA/BICSI 568 Standard for Installing Commercial Building Telecommunications Cabling.

C. Installation Methodology: Conform to the publications where such have been established for the particular installation in question. Publications of the organization listed below are applicable to the installation specified herein. Refer to the most recent adopted version.
   1. BICSI – Telecommunications Distribution Methods Manual.
   2. BICSI – Customer Owned Outside Plant Design Manual.

D. Definition of Terms
   1. Refer to individual sections
   2. Newton's Telecom Dictionary

1.3 CONTRACTOR QUALIFICATIONS

A. A minimum of 5 years' experience in the installation and service of voice/data cabling communications systems on projects of comparable size and scope.

B. A minimum of 5 years' experience in the installation and service of Outside Plant Cabling Systems on projects of comparable size and scope.

C. Registered with the equipment manufacturer(s) as franchised reseller of registered systems and serve as the installing contractor and ongoing registered service provider.

D. Registered Communications Distribution Designer (RCDD) certified by the Building Industry Consulting Service International (BICSI).

E. Installation personnel trained in the proper installation of extended performance data and voice cable, prior to installation, by outside training course or in-house training program.

F. Installation personnel trained in the proper installation of outside plant cabling, prior to installation, by outside training course or in-house training program.

G. Alarm and Communications License furnished by the Minnesota State Board of Electricity.

1.4 PERMITS

A. Secure and pay for licenses and permits required by the State and Municipality before work is started. Observe requirements of permits and licenses.

B. Schedule inspection of work and installations by the authority having jurisdiction.

1.5 SUPERVISION

A. Installations shall be made by persons licensed and skilled in the trade and shall be done under the supervision of a BICSI Registered Communications Distribution Designer (RCDD).

1.6 WARRANTY

A. Refer to the General Conditions and individual sections, for warranty of work under Division 27.

B. Warrant to the owner and Architect the following:

1. Materials and equipment furnished under the Contract will be of good quality and new unless otherwise required or permitted by the Contract Documents.
2. The Work will be free from defects not inherent in the quality required or permitted.
3. The Work will conform to the requirements of the Contract Documents.
4. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective.
5. Warranty excludes remedy for damage or defect caused by abuse, modifications not executed under this Contract, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage.
6. If required by the Architect, furnish satisfactory evidence as to the kind and quality of materials and equipment.

1.7 DRAWINGS

A. The Technology drawings indicate the arrangements of technology equipment. Review architectural drawings and details for door swings, cabinets, counters and built-in equipment; conditions indicated on architectural plans shall govern. Coordinate installation of technology equipment with structural system and mechanical equipment and access thereto.

B. Do not scale drawings. Obtain dimensions for layout of equipment from Architectural plans and details unless indicated on Technology plans.

C. Bring discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Architect.

D. Equipment layout is based on one manufacturer's product or from composite dimensions from multiple manufacturers. Where equipment selected for use on the job differs from layout, coordinate space requirements and connection arrangements.

1.8 SUBMITTALS

A. Pre-Construction
   1. List of Materials and Subcontractors:
      a. Refer to Division 01 for submittal requirements.
   2. Schedule of Values:
      a. Refer to Division 01 for submittal requirements.
      b. Provide a schedule of values for the technology contract work specified under Division 27. Include separate labor and material itemization for each line item requested.
      c. Provide the following line items as a minimum level of itemization:
         1) Mounting elements in Telecommunications Rooms, Equipment Rooms and Entrance Facilities.
         2) Copper Backbone Cabling.
         3) Fiber Backbone Cabling.
         4) Horizontal Cabling.
         5) Network Equipment.
         6) Outside Plant Cabling.
      d. The itemized schedule of values, above, will be used to determine project completion and progress for payment requests, including overhead and profit for each itemization. Schedule of values must be submitted and approved prior to first pay request.
   3. Shop Drawings and Product Data:
      a. Submit for review, shop drawings and product data of materials and equipment to be incorporated in the work. Support submittals with descriptive material, catalog cut sheets, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements. Provide complete electrical characteristics for equipment.
      b. Refer to the individual sections for identified equipment and materials for which submittals are required.
      c. Refer to the SHOP DRAWINGS, PRODUCT DATA AND SAMPLES section for required procedures.
      d. Neatly bound in a three ring or comb type binder, with protective covers. Identify the project, the site, system, date and vendor name on the cover
      e. Consisting of, but not be limited to the following items:

1) Title sheet showing the Project Name, Project Location, Specification Title and Specification number, Contractor's name, address, phone number, BICSI RCDD registration stamp with signature and date submitted. Provide clear area on the title sheet for shop drawing review stamps.
2) Organize submittal into logical sections and provide table of contents.
3) Material list showing quantity, manufacturer and description of each item being furnished.
4) On datasheets with multiple products, indicate which product is provided under this project.
5) Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.

f. Submit documents as a single package per site.
g. Submit within 2 weeks after award of contract.
h. The Contractor must neither order equipment nor proceed with installation until the Architect approves shop drawings.

B. Close-Out
1. Record Documents:
   a. Refer to Division 01 for record documents and related submittals.
2. Operation and Maintenance Data and Instructions
   a. Refer to Division 01 for detail requirements.
   b. Printed Material: Provide required printed material for binding in operation and maintenance manuals.
   c. Instructions of Owner Personnel:
      1) Schedule training with owner.
      2) Notify architect 2 weeks prior to training.
      3) Provide a competent representative to instruct Owner's designated personnel in systems under this division of the specifications before final inspection, as designated by the Architect. For equipment requiring seasonal operation, perform instructions for other season within six months unless requested otherwise.
      4) Use operation and maintenance manuals as basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
      5) Refer to the individual section for training specific to each system.
      6) Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.
      7) The owner reserves the right to videotape training.
   d. Document extent of training to include dates, times, location and attendance roster. Submit for inclusion in Operations and Maintenance Manual.

1.9 SITE INVESTIGATION

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions that may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original condition, with the exception of the work under this contract, before the completion of this project. Existing systems and conditions, which are not detailed on the drawings, must still be restored to their original condition.

1.10 COORDINATION

A. Coordinate entrance facility arrangement with the local exchange carriers and Cable TV service provider.

PART 2 PRODUCTS

2.1 MATERIALS

A. Materials shall be new.

B. Furnish materials specified herein or indicated on the drawings.

C. Materials of the same type shall be the products of one manufacturer.

D. UL listed material shall bear UL label. ETL listed material shall bear ETL label. ETL label shall be accepted in lieu of UL when the UL testing standards have been followed.

E. Work such as painting, patching, welding or carpentry related to the work of this Division shall be performed by the appropriate trade experienced in that work, but shall be provided for under this Division.

2.2 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

2.3 SPARE PARTS

A. Prior to the final inspection and at the time designed by the Architect, turn over to the Owner spare parts consisting of the following materials in the quantity specified. Materials shall be new, in the original packing, of the same manufacturer and type as installed on the project and comply with these specifications receive receipt for all materials turned over to Owner.

B. Submit copy of spare parts receipt to the architect.

PART 3 EXECUTION

3.1 PRODUCT DELIVERY, STORAGE, HANDLING, AND PROTECTION

A. Inspect materials upon arrival at Project and verify conformance to Contract Documents. Prevent unloading of unsatisfactory material. Handle materials in accordance with manufacturer's applicable standards and supplier’s recommendations, and in a manner to prevent damage to materials. Store packed materials in original undamaged condition with manufacturer's labels and seals intact. Containers, which are broken, opened, damaged, or watermarked are unacceptable and shall be removed from the premises.

B. Material shall be stored in an enclosed, dry building or trailer. Provide areas for general storage. Provide temperature and/or humidity controls where applicable. Equipment stored other than as specified above shall be removed from the premises.

C. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Conditions shall be those for which the equipment or materials are designed to be installed. Equipment and materials shall be protected from water, direct sunlight, cold or heat. Equipment or materials damaged or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced.

3.2 EQUIPMENT INSTALLATION

A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.3 FIRESTOPPING

A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Firestopping."

3.4 DEMOLITION

A. Protect existing equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Reroute cabling as required to serve equipment not in the demolition area.

C. Accessible Work: Remove exposed equipment and installations, indicated to be demolished, in their entirety.

D. Abandoned Work: Cut and remove buried cabling, indicated to be abandoned.

E. Remove demolished material from Project site.

F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

G. Remove devices on wall or ceilings being removed. Coordinate with other divisions.

H. Assume that existing equipment indicated to be reused is in good working condition and can be installed without repairs. Notify the Architect of items found to be in need of repair or in unusable condition for direction or decision. Repair any damage to equipment caused in removal or handling

I. Clean equipment removed and to be re-used before reinstallation

J. Carefully remove and deliver to the owner or store where directed on the site, material and equipment noted or required by the owner to be salvaged and which is not scheduled to be reused or relocated.

3.5 REFINISHING AND PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 09 Section "Painting."

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

B. Where plywood backboards are provided under Division 27 to mount equipment, paint backboards.

C. Do not paint trim covers for flush mounted cabinets, unless required by the Architect. Remove trim covers before painting. Under no conditions shall locks or exposed trim clamps be painted.

3.6 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

C. Clean accessible elements with compressed air (less than 15 PSI) and vacuum clean the interior of enclosures.

D. Periodically remove waste and rubbish from project site and maintain order. Premises shall be left clean and free of debris and unused construction materials prior to owner acceptance.

3.7 SERVICE OUTAGES

A. Technology work requiring interruption of telecommunications service, which would adversely affect the normal operation of the other portions of the Owner's property, shall be done at a time other than normal working hours. Normal working hours shall be considered 8:00 a.m. to 5:00 p.m., Monday through Friday.

B. Schedule work requiring interruption of telecommunications service two weeks prior to actual shutdown. Submit schedule in writing indicating extent of system to be interrupted, date and time when interruption is intended to occur, and date and time service will be restored. Schedule shall be subject to the approval of the Architect and the Representative of the Owner.

C. Cancellation: The Owner reserves the right to cancel or change the scheduling of any outage up to 24 hours before its approved starting time. There shall be no additional cost to Owner for scheduled outages, or for outages re-scheduled at the Owner's request where at least 24 hours notice has been given by the Owner.

3.8 CUTTING AND PATCHING

A. Do not endanger the stability of the structure by cutting, drilling or otherwise modifying the structural members of the building. Direct all requests for structural modifications to the Architect for approval. Proceed with these modifications only as directed by the Architect.

B. Cutting and patching requirements will be modified only if General Construction Specifications and drawings specifically state that certain portions or all cutting and patching required for each of the various trades is to be performed by the General Contractor.

C. Refer to General Construction Specifications for execution and requirements for patching and painting and comply with applicable provisions as to materials and quality of installation.

D. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit installations. Perform cutting by skilled mechanics of trades involved.

E. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.9 TECHNOLOGY SYSTEMS OPERATIONAL TESTS, MANUFACTURERS SYSTEMS CERTIFICATION AND DESIGN AUTHORITY ASSISTANCE

A. Testing:
   1. Refer to the individual specification sections for test requirements.
   2. Prior to the final inspection, the systems or equipment shall be tested and reported as therein specified. Five (5) typewritten copies of the tests shall be submitted to the Architect for approval.
   3. Test technology systems for compliance with the specifications.

B. Manufacturer's Certifications:
   1. Submit the technology systems design documentation for review by a representative of the manufacturer to verify compliance with the manufacturers recommendations and system operation. The manufacturer shall submit certification that the system has been reviewed and the design is in accordance with the manufacturer's recommendations.
   2. Submit the technology systems installation and operation for review by a representative of the manufacturer to verify compliance with the manufacturers recommendations and system operation. The manufacturer shall submit certification that the system has been reviewed and the installation is in accordance with the manufacturer's recommendations.
   3. Provide manufacturers certifications for the following systems:
      a. Structured Cabling.
      b. Outside Plant Cabling

C. Design Authority Assistance:
   1. Remove equipment covers for inspection of internal cabling.
   2. Remove accessible ceilings for inspection of equipment installed above ceilings.
   3. Demonstrate operation of equipment and systems.
   4. Remove manhole covers, pump manholes dry and provide a ladder for inspection of interior of manholes.
   5. Provide authorized representatives of the manufacturers to demonstrate to the compliance with the specifications of the respective systems during or prior to the final inspection at a time designated by the Architect. Refer to the specific specification section for additional testing requirements.
   6. Representatives of the following systems are required for demonstrations:
      a. Copper Backbone Cabling
      b. Fiber Optic Backbone Cabling
      c. Copper Horizontal Cabling
      d. Fiber Optic Horizontal Cabling
      e. Structured Cabling
      f. Outside Plant Cabling
      g. Switches, Hubs and Routers
      h. Video Distribution System

END OF SECTION

SECTION 270528
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal conduits and fittings.
   2. Metal wireways and auxiliary gutters.
   3. Nonmetallic wireways and auxiliary gutters.
   4. Metallic surface pathways.
   5. Nonmetallic surface pathways.
   6. Tele-power poles.
   7. Hooks.
   8. Boxes, enclosures, and cabinets.

1.2 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

D. RTRC: Reinforced thermosetting resin conduit.

1.3 ACTION SUBMITTALS

A. Product data for the following:
   1. Surface pathways
   2. Wireways and fittings.
   3. Tele-power poles.
   4. Boxes, enclosures, and cabinets.

1.4 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

PART 2 PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems, Inc.
   2. Allied Tube & Conduit.
   3. Anamet Electrical, Inc.
   4. Bridgeport Fittings, Inc.
   5. Electri-Flex Company.
   6. O-Z/Gedney.
   7. Picoma Industries.
   8. Republic Conduit.
   9. Robroy Industries.
   10. Southwire Company.
   11. Thomas & Betts Corporation.
   12. Western Tube and Conduit Corporation.
   13. Wheatland Tube Company.

C. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-D.

D. GRC: Comply with ANSI C80.1 and UL 6.

E. ARC: Comply with ANSI C80.5 and UL 6A.

F. IMC: Comply with ANSI C80.6 and UL 1242.

G. PVC-Coated Steel Conduit: PVC-coated GRC or IMC.
1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

H. EMT: Comply with ANSI C80.3 and UL 797.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Fittings for EMT:
   a. Material: Steel or Zinc die cast.
   b. Type: Setscrew or compression.
2. EMT Fittings Materials:
   a. All Zinc materials shall be ASTM B86 certified
   b. All Zinc Product shall be ZAMAK #3 and/or #7 formula.
   c. All Steel shall be SAE 1050.
3. EMT Fittings Design:
   a. Zinc die cast components shall be ball burnished.
   b. Steel parts shall be zinc plated for corrosion protection.
   c. All Locknuts shall have a dual, precision machined-cut thread, reversible and possess a serrated face on each side.
   d. All set screw products shall be manufactured with a tri-drive head and staked or modified to prevent disassembly.
   e. All fitting throat diameters shall be smooth with no sharp edges or slag.
   f. Rain tight products shall have internal sealing rings to create and maintain a rain tight seal.
   g. All fittings shall be tested per UL 514B and be listed by Underwriters Laboratories.
4. Transition Fittings:
   a. All transitions fittings (go-to or from-to fittings) or fittings used to transition from one raceway type to another must be UL listed for that application.
5. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cooper B-Line, Inc.
2. Hoffman.
3. Mono-Systems, Inc.
4. Square D.

C. General Requirements for Metal Wireways and Auxiliary Gutters:
1. Comply with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
3. Comply with TIA-569-D.

D. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

E. Wireway Covers: Hinged type unless otherwise indicated.

F. Finish: Manufacturer's standard enamel finish.

2.3 SURFACE METAL PATHWAYS

A. Description: Galvanized steel with snap-on covers, complying with UL 5.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Mono-Systems, Inc.
2. Niedax-Kleinhuis USA, Inc.
3. Panduit Corp.
4. Wiremold / Legrand.

C. Finish: Prime coated, ready for field painting.

D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

E. Comply with TIA-569-D.

2.4 SURFACE NONMETALLIC PATHWAYS

A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Lamson & Sessions; Carlon Electrical Products.
2. Mono-Systems, Inc.
3. Panduit Corp.
4. Quazite:Hubbell Power Systems, Inc.
5. Wiremold / Legrand.

C. Finish: Texture and color selected by Architect from manufacturer's standard colors.

D. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

E. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

F. Comply with TIA-569-D.

2.5 TELE-POWER POLES

A. Description: Prefabricated, finished metal pole with prewired power and communications outlets.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Mono-Systems, Inc.
2. Panduit Corp.
3. Wiremold / Legrand.

C. Material: Galvanized steel with ivory baked-enamel finish.

D. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

E. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

F. Comply with TIA-569-D.

2.6 HOOKS

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. B-Line
   2. Mono Systems, Inc
   3. Panduit Corp.
   4. Pentair
   5. Wiremold/Legrand

C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with TIA-569-D.

E. Galvanized steel.

F. J or U shape.

2.7 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Adalet.
   2. Cooper Technologies Company; Cooper Crouse-Hinds.
   3. EGS/Appleton Electric.
   4. Erickson Electrical Equipment Company.
   5. Hoffman.
   6. Lamson & Sessions; Carlon Electrical Products.
   7. Milbank Manufacturing Co.
   8. Molex; Woodhead Brand.
   9. Mono-Systems, Inc.
   10. O-Z/Gedney.
   11. Quazite:Hubbell Power Systems, Inc.
   12. RACO; Hubbell.
   13. Robroy Industries.
   14. Spring City Electrical Manufacturing Company.
   15. Stahlin Non-Metallic Enclosures.
   16. Thomas & Betts Corporation.
   17. Wiremold / Legrand.

C. General Requirements for Boxes, Enclosures, and Cabinets:
   1. Comply with TIA-569-D.
   2. Boxes, enclosures and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
   3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
   4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).
   5. Gangable boxes are prohibited.

D. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

F. Metal Floor Boxes:
   1. Material: Cast metal or sheet metal.
   2. Type: Fully adjustable.
   3. Shape: Rectangular.

4. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, round.
   1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

J. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

PART 3 EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC or IMC.
   2. Concealed Conduit, Aboveground: EMT.
   3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
   4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Pathway locations include the following:
      a. Loading dock.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical rooms.
      d. Gymnasiums
   4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   5. Damp or Wet Locations: GRC or IMC.
   6. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 3/4-inch (21-mm) trade size. Minimum size for optical-fiber cables is 1 inch (25 mm).

D. Pathway Fittings: Compatible with pathways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
   3. EMT: Use setscrew or compression, steel or Zinc die-cast metal fittings. Comply with NEMA FB 2.10 and UL514B.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
   1. NECA 1.
   2. NECA/BICSI 568.
   3. TIA-569-D.

4. NECA 101
5. NECA 102.
6. NECA 105.
7. NECA 111.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

D. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

E. Complete pathway installation before starting conductor installation.

F. Arrange stub-ups so curved portions of bends are not visible above finished slab.

G. Install no more than the equivalent of two 90-degree bends and no more than 100 feet (30 meters) of length in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.

H. Conceal rigid conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

I. Support conduit within 12 inches (300 mm) of enclosures to which attached.

J. Pathways Embedded in Slabs:
   1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
   2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
   3. Arrange pathways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
   4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
   5. Change from nonmetallic conduit and fittings to GRC or IMC and fittings before rising above floor.

K. Raceways Within 1 ½" of Roof Deck:
   1. All raceway shall be installed further from 1 ½" of roof deck or raceway shall be RMC or IMC.

L. Stub-ups to Above Recessed Ceilings:
   1. Use EMT, IMC, or RMC for pathways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

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

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

O. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

R. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.

S. Surface Pathways:
   1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
   2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points.
   3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

T. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.

U. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service pathway enters a building or structure.
   3. Where otherwise required by NFPA 70.

V. Hooks:
   1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
   2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
   3. Hook spacing shall allow no more than 6 inches (150 mm) of slack. The lowest point of the cables shall be no less than 6 inches (150 mm) adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
   4. Space hooks no more than 5 feet (1.5 m) o.c.
   5. Provide a hook at each change in direction.

W. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

X. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Y. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Z. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

BB. Set metal floor boxes level and flush with finished floor surface.

CC. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

DD. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

EE. Boxes installed in metal stud and sheetrock walls shall have far-side box support.

FF. Boxes shall be secured to metal studs with spring steel clamp which wraps around the entire face of the stud and digs into both sides of the stud. Clamp shall be screwed into the stud.

GG. Set outlet boxes for flush mounted devices to within 1/8” of finished wall.

HH. Minimum box size to be two gang. For installation of single gang device use properly sized mud ring with thickness to install device within 1/8” of finished wall.

II. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION

SECTION 270536
CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ladder cable trays.
   2. Wire-basket cable trays.
   3. Single-rail cable trays.
   4. Cable tray accessories.
   5. Warning signs.

B. Related Requirements:
   1. Section 078400 - Penetration Firestopping: For penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
   2. Section 260536 "Cable Trays for Electrical Systems" for cable trays and accessories serving electrical systems.
   3. Section 260526 “Grounding and Bonding for Electrical Systems” for grounding and bonding requirements.
   4. Section 270526 “Grounding and Bonding for Communications Systems” for grounding and bonding requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.
   1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.
   1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
   2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
      a. Vertical and horizontal offsets and transitions.
      b. Clearances for access above and to sides of cable trays.
      c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
      d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CABLE TRAY

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
   1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
   1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
   2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
   3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.2 LADDER CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Allied Tube & Conduit; a Tyco International Ltd. Co.
   2. Cablofil
   3. Chalfant Manufacturing Company.
   4. Cooper B-Line, Inc.
   5. Mono-Systems, Inc.
   6. MP Husky.
   7. Niedax-Kleinhuis USA, Inc.
   8. TJ Cope.

B. Description:
   1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
   2. Width: 24 inches (600 mm) unless otherwise indicated on Drawings.
   3. Minimum Usable Load Depth: 4 inches (100 mm).
   4. Straight Section Lengths: 10 feet (3 m) except where shorter lengths are required to facilitate tray assembly.
   5. Rung Spacing: 9 inches (225 mm) o.c.
   6. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
   7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
   8. No portion of the rungs shall protrude below the bottom plane of side rails.
   9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
   10. Fitting Minimum Radius: 24 inches (600 mm).
   11. Class Designation: Comply with NEMA VE 1, Class 10A.
   12. Splicing Assemblies: Bolted type using serrated flange locknuts.
   13. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:
   1. Aluminum:
      a. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 according to ANSI H35.1/H 35.1M for fabricated parts.
      b. Hardware: Chromium-zinc-plated steel, ASTM F 1136.
      c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.3 WIRE-MESH CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Allied Tube & Conduit; a Tyco International Ltd. Co.
   2. Cablofil
   3. Chalfant Manufacturing Company.
   4. Cooper B-Line, Inc.
   5. Enduro Systems, Inc.
   6. Mono-Systems, Inc.
   7. MP Husky.
   8. Niedax-Kleinhuis USA, Inc.
   9. TJ Cope.
   10. Snaketray.
   11. Wiremaid Products Division; Vutec Corporation.
   12. WBT, Inc.

B. Description:
   1. Configuration: Galvanized- steel wire mesh, complying with NEMA VE 1.
   2. Width: 18 inches (450 mm) unless otherwise indicated on Drawings.

3. Minimum Usable Load Depth: 4 inches (100 mm).
4. Straight Section Lengths: 10 feet (3.0 m), except where shorter lengths are required to facilitate tray assembly.
5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
6. Class Designation: Comply with NEMA VE 1, Class 10A.
7. Splicing Assemblies: Bolted type using serrated flange locknuts.
8. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:
   1. Steel:
      a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1008/A 1008M, Grade 33, Type 2.
      b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
      c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
      d. Finish: Hot-dipped galvanized after fabrication, complying with ASTM A123/A123 M, Class B2.
         1) Hardware: Galvanized, ASTM B 633.

2.4 SINGLE-RAIL CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Allied Tube & Conduit; a Tyco International Ltd. Co.
   2. Cablofil
   3. Cooper B-Line, Inc.
   4. Mono-Systems, Inc.
   5. MP Husky.
   6. TJ Cope.

B. Description:
   1. Configuration: An extruded-aluminum assembly, consisting of a single longitudinal center rail with transverse rungs arranged symmetrically about the center rail complying with NEMA VE 1.
   2. Construction: Aluminum rungs mechanically connected to aluminum center rail in at least two places, with ends finished to protect installers and cables.
   3. Width: 18 inches (450 mm) unless otherwise indicated on Drawings.
   4. Minimum Usable Load Depth: 4 inches (100 mm).
   5. Straight Section Lengths: 10 feet (3 m) except where shorter lengths are required to facilitate tray assembly.
   6. Rung Spacing: 9 inches (225 mm) o.c.
   7. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
   8. Support Point: Splice fittings shall be hanger support point.
   9. Support Spacing: Support each section at midpoint. Support wall-mounted sections a maximum of one-sixth of the section length from each end.
   10. Class Designation: Comply with NEMA VE 1, Class 10A.
   11. Unbalanced Loads: Maintain cable tray rungs within six degrees of horizontal under all loading conditions.
   12. Splicing Assemblies: Bolted type using serrated flange locknuts.
   13. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
   14. Splices and Connectors: Protect cables from edges of center rail and do not intrude into cable fill area.

C. Materials: Aluminum alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 according to ANSI H35.1/H 35.1M for fabricated parts.

D. Hardware: Chromium-zinc-plated steel, ASTM F 1136.

2.5 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

F. Fasten cable tray supports to building structure.

G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg). Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."

H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

J. Support cable tray assembly to prevent twisting from eccentric loading.

K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

L. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

M. Support wire-basket cable trays with trapeze hangers or wall brackets.

N. Support center support hangers or trapeze hangers for wire-basket trays with 3/8-inch- (10-mm-) diameter rods.

O. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

P. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

Q. Make changes in direction and elevation using manufacturer's recommended fittings.

R. Make cable tray connections using manufacturer's recommended fittings.

S. Firestopping: Provided by Section 078400 - Penetration Firestopping. Coordinate with Section 078400 for sealing of penetrations through fire and smoke barriers.

T. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

U. Install cable trays with enough workspace to permit access for installing cables.

V. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

W. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch (1800-mm) intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).

E. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.

3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70 and TIA/EIA-569-D. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.
1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

END OF SECTION

SECTION 270553
IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Color and legend requirements for labels.
   2. Labels.
   3. Tapes.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for communications identification products.

B. Identification Schedule:
   1. Outlets: Scaled drawings indicating location and proposed designation.
   2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
   3. Racks: Scaled drawings indicating location and proposed designation.
   4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70 and TIA 606-B.

B. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Equipment Identification Labels:
   1. Black letters on a white field.
   2. <Insert specific requirements for equipment to be labeled, such as racks, cabinets, etc.>.

2.3 LABELS

A. Self-Adhesive Wraparound Labels: Write-on, 3-mil- (0.08-mm-) thick, polyester flexible labels with acrylic pressure-sensitive adhesive.
   1. Manufacturers:
      a. A'n D Cable Products
      b. Brady Corporation
      c. Brother International Corporation
      d. emedco
      e. Grafoplast Wire Markers
      f. Ideal Industries, Inc.
      g. LEM Products Inc.
      h. Marking Services, Inc.
      i. Panduit Corp.
      j. Seton Identification Products
   2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
   3. Marker for Labels: Permanent, waterproof black ink marker recommended by tag manufacturer.

4. Marker for Labels: Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Self-Adhesive Wraparound Labels:
   1. Secure tight to surface at a location with high visibility and accessibility.
   2. Provide label 6 inches (150 mm) from cable end.

F. Self-Adhesive Labels:
   1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
   2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.

C. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, composed of the following, in the order listed:
   1. Telecom room designation.
   2. Colon.
   3. Faceplate number.

D. Equipment Room Labeling:
   1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
   2. Patch Panels: Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.

3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:
    a. Room number being served.
    b. Colon.
    c. Faceplate number.

E. Backbone Cables: Label each cable with a self-adhesive wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.

F. Horizontal Cables: Label each cable with a self-adhesive wraparound label indicating the following, in the order listed:
    1. Room number.
    2. Colon.
    3. Faceplate number.

G. Equipment Identification Labels:
    1. Indoor Equipment: Laminated-acrylic or melamine-plastic sign.
    2. Equipment to Be Labeled:
        a. Communications cabinets.

END OF SECTION

SECTION 271513
COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Category 6 twisted pair cable channel, permanent link for voice and data.
   2. Category 6a twisted pair cable channel, permanent link for voice and data.
   3. Twisted pair cable hardware, including plugs and jacks.
   4. Multiuser telecommunications outlet assembly.
   5. Cable management system.
   6. Cabling identification products.
   7. Grounding provisions for twisted pair cable.
   8. Source quality control requirements for twisted pair cable.

B. Related Requirements:
   1. Section 270526 “Grounding and Bonding for Communications Systems” for grounding conductors and connectors.
   2. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories.
   3. Section 280513 "Conductors and Cables for Electronic Safety and Security" for data cabling associated with system panels and devices.

C. Support the following network topologies:
   1. Analog Voice Circuits
   2. Digital Voice Circuits
   3. ISDN BRI
   4. DS-1
   5. DS-3
   6. Fractional T-1’s
   7. T-3’s
   8. Ethernet 10/100/1000Base-TX and 10GBASE-TX standards.

D. Registered with the manufacturers of the equipment as an installed system that meets industry standards for structured voice and data cabling systems. Manufacturers’ warrantee for a minimum period of 15 years for proper operation of any communications protocol designed to operate over the specified cabling system.

E. Documentation of the voice and data cabling system record./ recorded in cable management software.

F. Tested and documented for reference by the Owner.

1.2 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. LAN: Local area network.

H. Jack: Also commonly called an "outlet," it is the fixed, female connector.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.3 EXISTING CONDITIONS

A. Remove abandoned cables located within the confines of the project back to the source including:
   1. Existing cables no longer utilized or tagged for future applications.
   2. Cables abandoned within the scope of this project.

1.4 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
   1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
   2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
   3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft. (9.3 sq. m), and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect.

D. The voice and data cabling system shall support the future installation and connection of the following equipment. (Equipment not in contract.)
   1. Active data equipment at the Racks.
   2. Telephone equipment at the Racks.
   3. Telephone equipment at the Voice Backboards.
   4. Computers at the Workstation Outlets.
   5. Telephones at the Workstation and Wall Telephone Outlets.
   6. Wireless Local Area Network.
   7. Video Surveillance Cameras.

E. Patch Cord installation and Cross-Connect Cable installation not in contract.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.
   1. Title sheet showing the Project Name, Project Location, Specification Title and Specification number, contractor's name, address, phone number, RCDD Registration Stamp with signature and date submitted. Clear area shall be provided on the title sheet for shop drawing review stamps.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.

6. Provide certificates of training for Voice and Data premise cabling, per ANSI/TIA/EIA 568, for supervisors of installation personnel. Certificates shall be acceptable from a manufacturer of the equipment listed or an independent training company.
7. Manufacturers' catalog sheets with complete technical data for each item being furnished.
8. Confirmation that products are registered components for the manufacturer's warranty.
9. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
10. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
11. Cabling administration Drawings and printouts.
12. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
    a. Telecommunications rooms plans and equipment rack elevations.
    b. Telecommunications pathways.
    c. Telecommunications system access points.
    d. Telecommunications grounding system.
    e. Telecommunications conductor drop locations.
    f. Typical telecommunications details.
    g. Mechanical, electrical, and plumbing systems.

C. Twisted pair cable testing plan.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

C. As-Built/Record Drawings:
1. Two sets in hard copy format and two sets in electronic Auto CAD format, including bid submittals, revised shop drawing and product data showing:
    a. Final configuration of the system
    b. Final layouts of terminal boards, racks and cabinets
    c. Floor plans showing cable routes and workstation outlet locations with horizontal cable ids.
    d. Record of cross-connection configuration.
    e. Test results of horizontal cables listed by each Telecom room and horizontal cable id.
2. Hard copy information shall be in type written or printed form in a useful format.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Faceplates: One of each type.
2. Jacks: Ten of each type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing Agency must have personnel certified by BICSI on staff.
1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
1. Test each pair of twisted pair cable for open and short circuits.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.12 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Supply products, defined as part of the horizontal cabling system configuration, by a single manufacturer and listed cable partner.

C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

D. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
1. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

2.3 CATEGORY 6 TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMP NETCONNECT; a TE Connectivity Ltd. company
2. Belden CDT Networking
3. Berk-Tek Leviton; a Nexans/Leviton alliance
4. CommScope, Inc.

5. Draka USA.
6. General Cable; General Cable Corporation
7. Hitachi Cable America Inc.
8. Mohawk; a division of Belden Networking, Inc.
9. Superior Essex Inc.
10. SYSTIMAX Solutions; a CommScope, Inc. brand.

C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP).

F. Cable Rating: Plenum.

G. Jacket (Color):
1. Voice - Gray thermoplastic.
2. Data 1 - Blue thermoplastic.

2.4 CATEGORY 6A TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable with internal spline, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMP NETCONNECT; a TE Connectivity Ltd. company
2. Belden CDT Networking
3. Berk-Tek Leviton; a Nexans/Leviton alliance
4. CommScope, Inc.
5. Draka USA.
6. General Cable; General Cable Corporation
7. Hitachi Cable America Inc.
8. Mohawk; a division of Belden Networking, Inc.
9. Superior Essex Inc.
10. SYSTIMAX Solutions; a CommScope, Inc. brand.

C. Standard: Comply with TIA-568-C.2 for Category 6a cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP).

F. Cable Rating: Plenum.

2.5 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMP NETCONNECT; a TE Connectivity Ltd. company
2. Belden CDT Networking
3. Berk-Tek Leviton; a Nexans/Leviton alliance
4. CommScope, Inc.
5. Draka USA.
6. General Cable; General Cable Corporation
7. Hubbell Premise Wiring
8. KRONE Incorporated
9. Leviton Manufacturing Company
10. Mohawk; a division of Belden Networking, Inc.
11. Molex Premise Networks
12. Panduit Corp
13. Siemon Co. (The)
14. Superior Essex Inc.
15. SYSTIMAX Solutions; a CommScope, Inc. brand.
16. 3M

C. General Requirements for Twisted Pair Cable Hardware:
   1. Comply with the performance requirements of Category 6 and Category 6a.
   2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
   3. Cables shall be terminated with connecting hardware of same category or higher.
   4. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.

D. Field Configured Twisted Pair Patch Panel:
   1. IDC type, using modules designed for punch-down caps or tools.
   2. IDC Terminal Block Modules: Integral with connector bodies, including plugs and jacks.
   3. Angled face.
   4. Modular panels housing multiple numbered jack units with IDC-type connectors at each jack.
   5. Number of panels: As indicated on drawings.
   6. Number of ports: As indicated on drawings.
   7. Number of Jacks: One for each four-pair UTP cable, plus spares and blank positions adequate to satisfy specified expansion criteria.
   8. Labeling: White background designation strips with clear plastic covers integral to patch panel.
   9. Rear horizontal cable management.
   10. Mounting: Voice Rack, Data Rack, Equipment Rack, Equipment Cabinet

E. Preconfigured Twisted Pair Patch Panel:
   1. IDC type, using modules designed for punch-down caps or tools.
   2. Angled face.
   3. Modular panels housing multiple numbered jack units.
   4. Number of panels: As indicated on drawings.
   5. Number of ports: As indicated on drawings.
   6. Number of Jacks: One per port.
   7. Category 6A rated.
   8. Labeling: White background designation strips with clear plastic covers integral to patch panel.
   9. Rear horizontal cable management.
   10. Mounting: Voice Rack, Data Rack, Equipment Rack, Equipment Cabinet.

F. Pre-wired 25 Pair Twisted Pair Patch Panel:
   1. 50 position RJ21X Telco Connector
   2. Angled face.
   3. Modular panel housing multiple numbered jack units.
   4. Number of panels: As indicated on drawings.
   5. Number of ports: As indicated on drawings
   6. Number of Jacks: One per port
   7. Category 6 enhanced, rated.
   8. Labeling: White background designation strips with clear plastic covers integral to patch panel.
   9. Rear horizontal cable management.
   10. Mounting: Voice Rack, Data Rack, Equipment Rack, Equipment Cabinet.
   11. Termination: T568A, T568B, 2 pins/jack to match PBX requirements.

G. Plugs and Plug Assemblies:
   1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
   2. Standard: Comply with TIA-568-C.2.
   3. Marked to indicate transmission performance.

H. Jacks and Jack Assemblies:
   1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
   2. Designed to snap-in to a patch panel or faceplate.
   3. Standard: Comply with TIA-568-C.2.
   4. Category 6 or 6A.
   5. Marked to indicate transmission performance.
   6. Non-keyed.
   7. Colors:
      a. Voice - Owner selected thermoplastic.

b. Data 1 - Orange
c. Preconfigured and pre-wired 25 pair twisted pair patch panel – Black.

I. Workstation Outlets:
1. Wall
a. Single angled jack or multiple angled jacks as indicated on drawings.
b. Single gang faceplate with a minimum of four jack mounting openings and blanks to close unused openings.
c. Faceplate: Plastic.
d. Color for plastic faceplates: As selected by Architect unless indicated otherwise.
e. Labeling: White background designation strips with clear plastic covers integral to faceplate.
f. Mounting: Outlet box. Flush, in finished areas unless otherwise indicated, surface in unfinished areas.
2. Underfloor box.
a. Single or multiple jacks as indicated on drawings.
b. Single gang faceplate.
c. Faceplate: Stainless steel.
d. Labeling: White background designation strips with clear plastic covers integral to faceplate.
e. Mounting: Surface in outlet box.
3. Surface raceway.
a. Single angled jack or multiple angled jacks as indicated on drawings.
b. Single gang faceplate with a minimum of four jack mounting openings and blanks to close unused openings.
c. Faceplate: Plastic.
d. Color for plastic faceplates: As selected by Architect unless indicated otherwise.
e. Labeling: White background designation strips with clear plastic covers integral to faceplate.
f. Mounting: Flush in surface raceway.
4. Furniture. Type A.
a. Single jack or multiple jacks as indicated on drawings.
b. Single gang faceplate with a minimum of four jack mounting openings and blanks to close unused openings.
c. Faceplate: Plastic.
d. Color for plastic faceplates: As selected by Architect unless indicated otherwise.
e. Labeling: White background designation strips with clear plastic covers integral to faceplate.
f. Non-metallic device box 4-3/4”L x 3”W x 2-3/4”D.
g. Mounting: Flush on raceway cover, Surface on raceway cover, On shelf within furniture partition.
5. Furniture. Type B.
a. Single jack or multiple jacks as indicated on drawings.
b. Modular furniture adapter to match furniture manufacturer.
c. Labeling: White background designation strips with clear plastic covers integral to faceplate
d. Mounting: Flush in modular furniture.
6. Furniture. Type C.
a. Single jack or multiple jacks as indicated on drawings.
b. Integral plastic base plate and cover.
c. Labeling: Vinyl adhesive tape.
d. Color: Owner selected.
e. Mounting: Surface.
7. Ceiling.
a. Single jack.
b. Single gang faceplate.
c. Faceplate: Stainless steel.
d. Labeling: White background designation strips with clear plastic covers integral to faceplate.
e. Mounting: Outlet box. Flush, in finished areas unless otherwise indicated, surface in unfinished areas.

8. Wireless LAN Access Point.
    a. Single jack or multiple jacks as indicated on drawings.
    b. Integral plastic base plate and cover.
    c. Labeling: Vinyl adhesive tape.
    d. Color: Owner selected
    e. Mounting: Surface on structure above accessible ceiling tiles.

J. Card Access Control System Controller Panel Outlets:
    1. 12” coil of UTP cable inside of Controller Panel housing terminated with 8-position modular plug. Coordinate specific termination location with Security Contractor.
    2. Labeling: Vinyl adhesive tape.
    3. Refer to the Telecom Room enlarged plans for Controller locations.

K. Video Surveillance Camera Outlets:
    1. Wall or Ceiling
    2. 12” coil of UTP cable inside outlet box terminated with 8-position modular plug.
    3. Labeling: White background designation strips affixed to inside surface of outlet box.
    4. Mounting: Outlet box. Flush, in finished areas unless otherwise indicated, surface in unfinished areas.
    5. Refer to the E4xx series Electrical Systems drawings for locations and additional information.

L. Floor Box Outlets.
    1. Single jack or multiple jacks as indicated on drawings.
    2. Mount in service plate integral to floor box.
    3. Service plate and jack arrangement with adequate clearances to comply with TIA/EIA industry standards for maintaining proper bend radii on UTP horizontal cables behind jacks.
    4. Labeling: Vinyl adhesive tape.

M. Poke-Thru Outlets.
    1. Multiple jacks.
    2. Mount in service plate integral to poke-thru.

N. Voice Wall Outlets:
    1. Single jack.
    2. Mount in single gang faceplate.
    3. Faceplate: Stainless steel or plastic with mounting posts for wall mount telephone.
    4. Color for plastic faceplates: As selected by Architect unless indicated otherwise.
    5. Mounting: Flush, in finished areas unless indicated otherwise, surface in unfinished areas.

O. Voice Wall Communications Outlets in Weatherproof Telephone Enclosures: Enclosure for protection of standard wall phone from weather in outdoor installations and moisture in industrial installations with Voice Wall Communications Outlet inside.
    1. Weatherproof Enclosure:
        a. Approximate dimensions: 10.9 inches wide by 14.6 inches high by 10.5 inches deep.
        b. Material: glass-reinforced polyester.
        c. Hinged, gasketed door, with latch.
        d. NEMA Rating: 4X
        e. Number of Enclosures: As indicated on drawings.
        f. Manufacturer: GAI-Tronics Model 255 or Approved Substitute.
    2. Voice Wall Communications Outlet:
        a. Single Jack.
        b. Mount in single gang faceplate.
        c. Faceplate: Stainless steel with mounting posts for wall mount telephone.
        d. Mounting: Flush, inside weatherproof enclosure.

P. Weatherproof Outlets. Type A:
    1. Single jack or multiple jacks as indicated on drawings.
    2. Single gang.
    3. Weatherproof cast cover:
        a. Vertical cast construction, baked-on electrostatic polyester paint for scratch and corrosion resistance.

b. Covers shall be spring loaded so as to close automatically when patch cords are removed. Springs shall be stainless steel.
c. Heavy duty gasket shall provide weatherproofing between cover plate and box.

4. Mounting: Outlet box. Flush, in finished areas unless otherwise indicated, surface in unfinished areas.

Q. Weatherproof Outlets. Type B:

1. Single jacks or multiple jacks as indicated on drawings.
2. Single gang faceplate.
3. Faceplate: Stainless steel with rear sealing gasket. Protective cap with retention chain to seal jacks from liquid when not in use.
4. IP65 and IP67 rated seal.
5. Labeling: Vinyl adhesive tape.
6. Mounting: Outlet box. Flush, in finished areas unless otherwise indicated, surface in unfinished areas

R. Weatherproof In-use Outlets. Type C:

1. Single jacks or multiple jacks as indicated on drawings.
2. Single gang faceplate.
3. Body, cover, and plates shall be made of polycarbonate, or cast aluminum, with pre-applied gasket to box, made of closed-cell foam, neoprene blend regular density and UL rated HBF.
4. Include provision to keep water out, including patch cord passage slot.
5. Keyed mounting holes and install capability without removing device.
6. Mountable either horizontally or vertically.
7. Conforms to NEMA 3R.

S. Patch Cords and Cross-Connect cable:

1. UTP Data Patch Panel Patch Cords:
   a. Factory assembled
   b. Four-pair cables
   c. RJ-45 plug at each end.
   d. Non-keyed plugs.
   e. Category 6, Augmented category 6.
   f. Strain relief boots.
   g. Jacket color: Black.
   h. T568A termination
2. UTP Voice Patch Panel Patch Cords:
   a. Factory assembled
   b. Four-pair cables
   c. RJ-45 plug at each end.
   d. Non-keyed plugs.
   e. Category 6
   f. Strain relief boots.
   g. Jacket color: White
   h. T568A termination
3. UTP Data Workstation Patch Cords:
   a. Factory assembled
   b. Four-pair cables.
   c. RJ-45 plug at each end.
   d. Non-keyed plugs.
   e. Category 6, Augmented Category 6.
   f. Strain relief boots.
   g. Jacket color: Red.
   h. T568A termination
4. UTP Voice Workstation Patch Cords:
   a. Factory assembled
   b. Four-pair cables
   c. RJ-45 plug at each end.
   d. Non-keyed plugs.
   e. [Category 3, Category 5 enhanced, Category 6, Augmented Category 6].
   f. Strain relief boots.

g. Jacket color: White
h. T568A termination

T. General Purpose non-metallic split duct:
1. Color: Black.
2. Size: As necessary for the quantity of cables enclosed.

U. Legend:
1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.6 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Cable Markers: Vinyl wraparound adhesive tape markers, machine printed with black lettering on white background.

C. ½" wide vinyl adhesive tape machine printed with 3/8" high black lettering on white background.

2.7 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors, connectors, and grounding busbars.

B. Comply with TIA-607-B.

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568-C.1.

C. Factory test twisted pair cables according to TIA-568-C.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.
1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."

B. Comply with Section 270528 "Pathways for Communications Systems."

C. Comply with Section 270528.29 "Hangers and Supports for Communications Systems."

D. Comply with Section 270536 "Cable Trays for Communications Systems."

E. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Methods Manual" (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. Provide continuous lengths of horizontal cable from patch panel termination to jack termination without splices.
7. Conceal cabling except in unfinished spaces.
8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI's "Information Transport Systems Installation Methods Manual" (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools. Provide tie wraps to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommendations.
11. Install cable without damaging conductors, shield, or jacket.
12. Do not bend cable in handling or in installing to smaller radii than minimums recommended.
13. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
14. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
15. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
16. Pulling Cable: Comply with BICSI's "Information Transport Systems Installation Methods Manual" (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
17. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
    a. Pull cables simultaneously if more than one is being installed in the same raceway.
    b. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
    c. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage media or raceway.
18. Provide cover plates for outlet boxes including outlets in modular furniture. Provide blank plates for boxes that are indicated on the plans but are not indicated to receive outlet faceplates and jacks.
19. Provide weatherproof cover for all workstation outlets indicated as weatherproof.
20. Seal cable entry on underfloor workstation outlets.
21. Install furniture workstation outlet on owner furnished furniture.
22. Install furniture workstation outlet in Division __, owner furnished modular furniture.
23. Provide service plate and faceplate for mounting of jacks in floor boxes. Floor boxes provided by Division 26.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 48 inches (1219 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
4. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

D. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.

E. Equipment Rooms and Telecom Rooms
1. Mount connectors and terminal equipment hardware on backboards, and racks unless otherwise indicated.
2. Group connecting hardware for cables into separate logical fields as indicated on drawings.
3. Use patch panels for data and cross connect panels for voice to terminate cables entering the space, unless otherwise indicated.
4. Provide supporting connections from racks to structural ceiling or adjacent wall. Anchor rack bases to structural floor.
5. Provide one spool of each color combination and type of cross-connect cable with wall brackets in each telecommunications room and equipment room. Locate wall bracket [adjacent to, on] voice cross-connect backboard.
6. Provide 25’ service loop on horizontal voice cables at the telecom room end of the cables for future termination in the data racks.

F. Outlet configuration:
1. Provide 1 voice jack and 2 data jacks at each workstation voice/data outlet unless noted otherwise.
2. Provide 1 data jack at each ceiling workstation data outlet unless noted otherwise.
3. Provide 1 voice jack and 2 data jacks at each floor box voice/data outlet unless noted otherwise.
4. Provide 1 voice jack and 2 data jacks at each poke-thru voice/data outlet unless noted otherwise.
5. Provide 1 voice jack at each voice wall outlet unless noted otherwise.
6. Provide 1 data jack at each Wireless LAN access point outlet unless noted otherwise.
7. Provide 1 data jack at each Video Surveillance Security Camera outlet unless noted otherwise.

G. Jack terminations:
1. Terminate jacks and furnish patch cords to the T568A pin/pair assignment, unless noted otherwise.

H. Separation from EMI Sources:
1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

D. Provide conduit sleeves through penetrations of fire rated walls and floor/ceiling penetrations.

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter and Section 270526 “Grounding and Bonding for Communications Systems.

B. Comply with J-STD-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 3/0 grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

E. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

F. Ground equipment racks and cable tray to Telecommunications Grounding Busbar.

G. Install a copper bonding jumper from each section or fitting of the cable tray system to the next section or fitting of the cable tray system.

H. Bond cable shields, screens and drain conductors to Telecommunications Grounding Busbar.

3.6 PATCH CABLES

A. Furnish and install at the direction of the owner the following patch cables:

1. UTP Data Patch Panel Patch Cords:
   a. Quantities to patch 110% of terminated Patch Panel Data Jacks.
   b. Lengths:
      1) 10% at 2’ length.
      2) 20% at 3’ length.
      3) 30% at 4’ length.
      4) 30% at 6’ length.
      5) 10% at 8’ length.
2. UTP Data Workstation Patch Cords:
   a. Quantities to patch 110% of terminated Workstation Data Jacks.
   b. Lengths:
      1) 50% at 6’ length.
      2) 50% at 10’ length.
3. UTP Voice Patch Panel Patch Cords:
   a. Quantities to patch 110% of terminated Patch Panel Voice Jacks.
   b. Lengths:
      1) 10% at 2’ length.
      2) 20% at 3’ length.
      3) 30% at 4’ length.
      4) 30% at 6’ length.

5) 10% at 8’ length.

4. UTP Voice Workstation Patch Cords:
   a. Quantities to patch 110% of terminated Workstation Voice Jacks.
   b. Lengths:
      1) 50% at 6’ length.
      2) 50% at 10’ length.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
   1. Administration Class: Class 2.
   2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration, including optional identification requirements of this standard.

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:
   1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
   3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
   4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
      a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
      b. Label each unit and field within distribution racks and frames.
   5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
   1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:
   1. Visually inspect twisted pair cabling jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test 100% of voice and data, UTP horizontal cables for performance to TIA/EIA-568-C.2, category 5 enhanced, permanent link, channel requirements. The test instrument shall conform to the TIA/EIA-1152 Level II-e, measurement accuracy. Test 100% of voice and data, UTP horizontal cables for performance to TIA/EIA-568-C.2, category 6, permanent link, channel requirements. The test instrument shall conform to the TIA/EIA-1152 Level III, measurement accuracy. Test 100% of UTP horizontal cables for performance to TIA/EIA-568-C.2, augmented category 6, permanent link requirements. The test instrument shall conform to the TIA/EIA-1152 Level III-e, measurement accuracy.
4. Test 100% of voice horizontal cables for performance to TIA/EIA-568-C.2, category 3, permanent link requirements.
5. Replace and retest any cable that fail to pass the performance requirements.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to review the following with the Owner's maintenance personnel.
1. Labeling system and cross-reference to documentation.
2. Interpretation of cable test results.
3. Review data in maintenance manuals.
4. Warranty procedures.

B. Schedule training with Owner, through Architect, with at least seven days advance notice. Owner training to include, but not be limited to the following:
1. Final walk-thru of all Telecom Spaces.
2. Review of hard copy and electronic as-built drawings indicating workstation outlet locations and cable ids.
3. Review of cable test data.

3.10 SPARES

A. Extra Horizontal Cables:
1. Provide extra horizontal cables to locations above the ceilings for future installation to workstation outlets. Quantities of horizontal cables provided shall be sufficient to allow for a 10% growth above the initial quantity of workstation outlets indicated on drawings.
2. Half of the total quantity of extra horizontal cables are to be of sufficient length to reach to future workstation outlets that are located the greatest distance from the Telecommunications rooms.
3. Coil extra horizontal cables above the ceilings at locations as indicated on drawings.
4. Terminate horizontal cables on to twisted pair patch panels in Telecommunications rooms. Leave horizontal cables unterminated at the workstation end of the cables above the ceilings.

END OF SECTION

SECTION 275123
INTERCOM SYSTEM

PART 1 GENERAL

1.1 APPLICABLE DOCUMENTS

A. The Drawings, the provisions of the Contract, including General and Supplementary Conditions, and the General Requirements apply to the Work of this Section.

B. All Division 26, 27 Sections.

C. Division 28 – Access Control; Video Surveillance.

1.2 SUMMARY

A. Section includes:
   1. Intercom system work performed by a qualified security contractor:
      a. Intercom Substations.
      b. Intercom Master Stations.
      c. Transient Protection.
      d. Coordination with the Security Integrator.
   2. Intercom system work performed by the Hennepin County Security System Integrator:
      a. Integration with the Access Control and Video systems.
      b. Connection to Hennepin County Local and Wide Area Exchange.
      c. Security Operations Center workstation graphics.
      d. Network coordination and connection to the Hennepin County Security Wide Area Network.
      e. Coordination with the Security Contractor.

1.3 QUALITY ASSURANCE

A. Required Qualifications for the Security System Integrator:
   1. The Security Integrator must be the existing Hennepin County Service Vendor for Andover Access Control Systems, Pelco Video systems, and Stentofon Intercom Systems.

B. Required Qualifications for the Security Contractor:
   1. Security Contractor must have the necessary trained, licensed, and bonded trade and technical persons necessary to perform the tasks required under this specification.
   2. Security technicians shall be licensed as Power Limited Technicians through the Minnesota State Board of Electricity and have successfully completed an accredited, industry related, electronics course.
   3. Security Contractors shall, upon request, submit individual training and/or certification documentation for any service technician providing services under this specification.
   4. Security Contractor must be able to demonstrate that they have had a minimum of three (3) years' experience in the intercom field of commercial, institutional and/or industrial facilities (non-residential) within the confines of the thirteen (13) county Minneapolis-St. Paul- Bloomington MN-WI Metropolitan Statistical Area (The MN-WI MSA consists of the counties of Hennepin, Anoka, Carver, Chisago, Dakota, Isanti, Ramsey, Scott, Sherburne, Washington and Wright in Minnesota and Pierce and St. Croix in Wisconsin).
   5. The Security Contractor shall furnish a minimum of two (2) customer references within said thirteen (13) county MSA, at least one of which shall be substantially similar in size and scope to these specifications. References may be from either the public or private sector.
   6. Security Contractor, on a 24 hour/7 day per week basis, must be able to respond to emergency service within two (2) hours of an emergency service request.
   7. Security Contractor technicians must be factory certified in the Stentofon Alpha Comm product line.
   8. Security Contractor must employ in-house personnel to maintain and submit electronic record documentation in the most current AutoCAD format to Hennepin County.
   9. Security Contractor must currently support at least one (1) Stentofon AlphaComm (in the public or private sector) of substantially similar size and complexity which resides on a wide area network.

10. Security Contractor must provide all Stentofon programming software utilities required to configure the intercom system.

1.4 SUBMITTALS

A. Submit per the general requirements of the project specifications.

B. In addition:

1. The security contractor shall submit to the engineer all data sheets for components provided by the security contractor. The security integrator shall submit data sheets for components provided by the security integrator. These components are identified in Section 2. The parts list and the corresponding data sheets shall be submitted in the same order in a single PDF file. Multiple PDF files will be rejected.
2. The Security Integrator shall submit all as-built drawings in Autocad format. As-builts shall include:
   a. Floorplans showing symbols for all devices Details plans showing wiring terminations to all devices and control equipment and interfaces to other systems such as fire alarm and elevator controls.
   b. Riser diagrams showing interconnection of all devices and control locations Schedules noting device types and configuration data Elevations of equipment racks Operator and Maintenance Manuals shall be submitted as electronic documents or media. Hardcopy shall only be submitted if electronic versions are not available.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Package, handle, deliver and store at the job site in a manner that will avoid damage.

B. Provide locked storage units Contractor shall not deliver, store, or install any product in construction areas where the product is subject to damage from water, dust, and construction debris.

1.6 WARRANTY

A. Provide warranty per the general and supplemental conditions of the contract.

PART 2 PRODUCTS

2.1 PRODUCTS

A. The following products are standard products in use throughout Hennepin County facilities. No substitutions are allowed. If a listed product cannot be provided, notify the engineer in writing prior to the final addendum date and an alternative product will be identified.

B. The following products shall be provided by the Security System Integrator.

1. Intercom Exchange
   a. Minimum Requirements:
      1) Expand the existing exchange located in the Hennepin County Security Operations Center Dimensions (WxHxD) 332 x 44 x 340 mm / 13.07 x 1.73 x 13.38 inch.
      2) Weight 2 kg / 4.40 lbs.
      3) Power 90-270 V AC 4 W max.
      4) Mounting: 19” rack Temperature range -15 C to +55 C
      5) Relative humidity 95%
      6) Processor subsystem Intel IXP425 with HW acceleration for packet processing and encryption.
      7) Media subsystem DSP @ 1600 MIPS FPGA @ 400K gates.
      8) Storage subsystem Solid state (64 MB Flash) SIM card (IP configuration, HW-ID).
      9) Memory 128 MB SDRAM 1 MB NVRAM.
      10) Subscriber Capacity 552 intercom stations per server.
      11) IP Telephones 552 IP telephones per server.
      12) Priority features Group Call 250 groups Unlimited number of participants Priori y features Call Modes Open mode Ringing mode Call request mode Priority features.
      13) Audio messaging PA broadcasting Auto-attendant, Voice guidance (doors, elevators).
      14) Security voice response Compliance CE, FCC Part 15.

b. Approved Products:
1) Zenitel XE1 V.11.

C. The following products shall be provided by the Security Contractor unless noted otherwise.
1. IP Intercom Substation.
a. Minimum Requirements:
1) Faceplate: 11 gauge, #304 Stainless Steel.
2) Dimensions: 4 ½" H X 4 ½" W x 2 ½" D.
3) Protection Class: IP 64 with proper installation.
4) Speaker: 2X2 square, 45 ohm, 5 watt, waterproof.
5) Power: Power over Ethernet, IEEE 802.3 a-f, class 0 Local Power 24VDC.
6) Indicator: LED behind translucent red epoxy bonded Lexan lens.
7) Mounting: Surface or Flush, depth of 2.5" required.
8) Connectors: 1 RJ45 (Ethernet) 10/100 Mbps, 6 I/O's, 1 Relay Contact.
9) IP Protocols: IP v4- TCP-HTTPS-TFTP-RTP-RTCP-DHCP-SNMP-DiffServ-TOS-Stentofon CCoIP
10) LAN Protocols: Power over Ethernet (IEEE 802.3 a-f), VLAN (IEEE 802.1pq), Net ork Access Control (IEEE 802.1x), STP (IEEE 802.1d), RSTP (IEEE 802.1d-2004).
11) Audio Technology: Wideband 200 Hz – 7 kHz (G.722) Telephony 3.4 kHz (G.711) Acoustic Echo Cancellation, Open Duplex, Adapter Jitter Buffer, 10 Watt Class D Ampli ier, Electret Microphone.
12) Management and Operation: HTTPS (Web Configuration), DHCP and static IP, Remote Software Upgrade, Centralized Monitoring, Status LED.
b. Approved Products:
1) Zenitel IP Turbine Mini Substation 1078191000.
2. Intercom Master Station
a. Minimum Requirements:
1) Mounting Table top.
2) Dimensions: (W x H x D) 72 x 140 x 270 mm, 2.8 x 5.5 x 10.6 inch.
3) Weight 0.4 kg (.89 lbs.).
4) Temperature range 0˚C - 55˚C, 32˚C - 131˚F.
5) Humidity Non condensing, 10% - 85% RH.
6) Max SPL 85 dB at 1m.
7) Loudspeaker Impedance 8 ohm.
8) Frequency Range 300 - 7000 Hz.
9) Connector 1 x RJ45 (Ethernet) 10/100 Mbps.
10) Direct access display 10 lines, 5-8 charac ers graphic Information display 4 lines, 20 characters graphic.
11) Power consumption Power over Ethernet, IEEE 802.3 a-f, Class 0, Idle 4W, max. 8W.
12) IP protocols IP v4 - TCP - UDP - HTTPS – TFTP - RTP - RTCP -DHCP - SNMP - DiffServ -
13) TOS – STENTOFONCCoIP®.
14) LAN protocols Power over Ethernet (IEEE 802.3 a-f), VLAN(IEEE 802.1pq).
15) Network Ac ess Control (IEEE 802.1x), STP (IEEE 802.1d).
16) RSTP (IEEE 802.1d-2004).
17) Audio technology Wideband 200 Hz - 7 kHz (G.722).
18) Telephony 3.4kHz (G.711).
19) Active noise filtering.
20) Acoustic echo cancellation.
21) Open duplex.
22) Adaptive jitter filter.
23) Handset and volume override.
24) Management and operation DuHTTPS (Web configuration).
25) DHCP and static IP.
26) Remote automatic software upgrade.
27) Centralized monitoring.
28) Status LED.
b. Approved Products:
1) Stentofon IP Dual Display 1008007000.
3. Transient Protection

a. Minimum Requirements:
   1) Agency Approvals: UL497B.
   2) Standards Compliance: CAT5e, EIA/TIA568A, EIA/TIA568B.
   3) Connection Method: RJ45 In/Out Pinout: All 8 pins are protected.
   4) Data Rate: Gigabit Ethernet.
   5) Max Continuous Current: 1.5 Amps.
   6) Dissipation: 3,000W/pair (10/1000µs impulse).
   7) Protection Modes: Line-Ground (All).
   8) Operating Temperature: -40°F - 158°F (-40°C - 70°C).
   9) Maximum Humidity: 95% non-condensing Dimensions: 1.7” x 3.0” x 1.2” (43mm x 76mm x 30mm) Weight: 4oz (113g).
   10) Housing: ABS.
   11) Service Voltage 48V MCOV 64V.
   12) Clamp Voltage 72V Peak.
   13) Surge Current 30A/pair.

b. Approved Manufacturers:
   1) Ditek DTK-MRJPOE.

4. Cabling
   a. Fiber and CAT6 cabling shall be provided by the Network cabling contractor unless noted otherwise.
   b. Provide all other cables as require275d for a complete and operational system.
   c. Install per ANSI/TIA 568 and 569.
   d. Provide J Hook cable supports for all cabling.
   e. Where basket tray is provided for low voltage cabling, install cabling in the partition desig ated for the intercom system.

PART 3 EXECUTION

3.1 INSTALLATION AND OPERATIONAL REQUIREMENTS FOR THE SECURITY INTEGRATOR

A. Define intercom numbering and naming requirements and communicate requirements to the Security Contractor.

B. Coordinate with Hennepin County to define IP addressing requirements for all devices. Submit addressing requirements to the Security Contractor.

C. Program the intercom master programmable button and displays per Hennepin County standards.

D. Provide any additional configuration requirements to the Security Contractor.

E. Integrate the intercom system provided by the Security Contractor with the Andover Access Control system per Hennepin County Standards.

F. Program the system to rollover to the Hennepin County Security Operations Center if not answered at the local intercom master. The owner shall determine the rollover time period. The system shall normally be forwarded to the Security Operation Center. When forwarded, there shall be no rollover delay when calling the Security Operations Center.

G. Local and Security Operations Center Workstations:
   1. Provide control icons on the access control graphics for each intercom.
   2. Provide Andover “Video Monitor” camera call ups for each intercom.

H. The security integrator shall provide the local intercom exchange. Rack mount the exchange as shown on plans.

3.2 INSTALLATION REQUIREMENTS FOR THE SECURITY CONTRACTOR

A. Provide intercom substations, cabling, and transient protection. The local intercom exchange is provided by the Security Integrator

B. Demonstrate intercom system operation to the Security Integrator.

C. Intercom Substations:

1. All intercoms must be installed in a backbox as shown in the details drawings to ensure acoustical quality.
2. Prior to electrical rough in, the security contractor shall schedule a coordination meeting where each Intercom location will be reviewed with:
   a. The General Contractor, Electrical Contractor, Security Integrator, Hennepin County Security, and the Engineer.
   b. Coordinate installation of the elevator substation and cabling with the elevator contractor.
   c. Coordinate installation of the vehicle entrance gate with the County Vendor for parking controls.

D. Building Entrance Points
   1. A building entrance point enclosure shall be provided by the electrical contractor where shown on plans. Coordinate location of devices with the associated contractors. Refer to detail drawings.

E. Cabling
   1. Horizontal CAT cabling is provided by others.
   2. Coordinate final device locations with the cabling contractor.

3.3 TRAINING

A. The Security Integrator shall provide a minimum of 3 training sessions. Each session shall last a minimum of two hours.
   1. Training shall include:
      a. Operator Training – Use of the controls.
      b. Building Engineer Training – Review installation, As-Builts, and Maintenance.

3.4 PROJECT CLOSEOUT

A. The Security Integrator shall conduct a final acceptance test with the Owner and Engineer after initial system testing is complete and as built documentation has been submitted.
   1. Upon completion of the above items and all requirements identified in the plans and specifications:
      a. Notify the engineer in writing and request final acceptance.
      b. Conduct an on-site demonstration to the engineer of system performance and compliance with the plans and specifications.
      c. Correct any items noted by the engineer during acceptance and submit a signed punch list of corrections made.
   2. The Security Integrator shall conduct the final acceptance test and provide all submittals below.
      a. Each intercom shall be tested in sequential order and a corresponding test report shall be submitted to the engineer.
      b. Test each of the following for proper operation:
         1) Intercom call button operation.
         2) Intercom substation ID on master station display.
         3) Camera call up.
         4) Audio intelligibility and volume.
         5) Verify intercom master buttons and displays are programmed.
         6) Verify call forwarding to the SOC is programmed and staff are trained.
         7) Cables are properly labeled, routed and secured.
         8) Submit a summary report of test findings.

B. The Security Contractor shall attend the final acceptance test and make repairs as identified by the Engineer.

END OF SECTION

SECTION 280500
COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Electronic safety and security equipment coordination and installation.
   2. Common electronic safety and security installation requirements.
   3. Demolition.
   4. Cutting and patching for electrical construction.
   5. Touchup painting.
   6. Disposition of existing materials and equipment.
   7. Electronic Safety and Security Service Outage and Energizations.

B. Related Requirements:
   1. Section 078400 - Penetration Firestopping: For penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Comply with State and /or City Code requirements.

D. All materials shall meet the standards of the following institutes where applicable:
   1. National Fire Protection Association (NFPA)
   2. American Society of Testing Materials (ASTM)
   3. American National Standards Institute (ANSI)
   4. National Electrical Manufacturer's Association (NEMA)
   5. Institute of Electrical and Electronic Engineers (IEEE)

1.3 COORDINATION

A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Section 083100 "Access Doors and Panels."

D. Coordinate chases, slots, inserts, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

1. Core drilling through post-tensioned slab: The existing post-tensioned slabs contain post-tensioned tendons that must not be damaged or broken. No nailing, drilling, cutting or other disruption to the slab is allowed without prior written approval by the structural engineer. Contractor shall positively locate the existing tendons and submit to the structural engineer for approval a written procedure, including plans showing existing tendon locations and proposed disruption of the slab.

E. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

F. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability. Document results of said testing.

1.4 DRAWINGS

A. The drawings indicate the arrangements of electrical equipment. Review architectural drawings and details for door swings, cabinets, counters and built-in equipment; conditions indicated on architectural plans shall govern. Coordinate installation of electrical equipment with structural system and mechanical equipment and access thereto. Coordinate installation of recessed electrical equipment with concealed ductwork and piping, and wall thickness. All devices, raceway, and electrical equipment in finished and/or public spaces shall be recessed or concealed unless otherwise noted.

B. Do not scale drawings. Obtain dimensions for layout of equipment from Architectural plans and details unless indicated on Electrical plans.

C. Bring discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Architect.

D. Equipment layout is based on one manufacturer's product or from composite dimensions from multiple manufacturers. Where equipment selected for use on the job differs from layout, coordinate space requirements and connection arrangements.

1.5 SITE INVESTIGATION

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions which may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original condition, with the exception of the work under this contract, before the completion of this project. Existing systems and conditions which are not detailed on the drawings must still be restored to their original condition.

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

3.2 FIRESTOPPING

A. Firestopping: Provided by Section 078400 - Penetration Firestopping. Coordinate with Section 078400 for sealing of penetrations through fire and smoke barriers.

3.3 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Reroute safety and security cables as required to serve equipment not in the demolition area.

C. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

D. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

E. Remove demolished material from Project site.

F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

G. Remove devices on wall or ceilings being removed. Coordinate with other divisions.

H. Assume that existing equipment and fittings indicated to be reused are in good working condition and can be installed without repairs. Notify the Architect of items found to be in need of repair or in unusable condition for direction or decision. Repair any damage to equipment caused in removal or handling

I. Fittings and other equipment removed and to be-used shall be cleaned before reinstallation.

J. Added Cables: All cables added shall be coordinated with existing to remain. Where additional cables are added, identify cables per the system as exists in the facility.

K. All material and equipment which is noted or required by the owner to be salvaged and which is not scheduled to be reused or relocated shall be carefully removed and shall be delivered to the owner and stored where directed on the site.

L. Remove abandoned low voltage wiring. All wiring disconnected on one or both ends is considered abandoned unless tagged and labeled “future” or “spare”. Verify with Owner any cabling connected on both ends is still in use prior to removal.

3.4 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.5 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:
   1. Firestopping.
   2. Electrical demolition.

3. Cutting and patching for electrical construction.
4. Touchup painting.

3.6 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Section 099000 "Painting."
   1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
   2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
   3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.7 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

3.8 ELECTRONIC SAFETY AND SECURITY SERVICE OUTAGE AND ENERGIZATIONS

A. Owner Approval: Electronic safety and security service outages or energizations required shall be approved by the Owner before outages or energization. Outages shall be scheduled at the convenience of the Owner.

B. Written Request: Requests for outages and energizations shall be submitted in writing to the Owner for approval at the earliest possible date and in no case later than 14 days prior to the outage and/or energization.

C. Cancellation: The Owner reserves the right to cancel or change the scheduling of any outage up to 24 hours before its approved starting time. There shall be no additional cost to Owner for scheduled outages, or for outages re-scheduled at the Owner's request where at least 24 hours' notice has been given by the Owner.

D. Schedules: A minimum of two (2) weeks before the first outage, submit a schedule of proposed sequence of the electronic safety and security services outages and energizations. This schedule shall show construction energizations and shall include any weekend work. The schedule shall list the work to be completed during and between each outage.

E. Minimize outages on the Owner's electronic safety and security systems and employ sufficient workmen so that work will be carried on concurrently at more than one location, when necessary.

F. Before submitting any energization and/or outage requests, provide the owner with evidence that the following requirements have been met:
   1. Required equipment and material is on the job site. All related installations that can be worked on without an energization and/or outage are complete, tested, available for inspection, and ready for service.
   2. Shop drawings, test reports, installation data, and operational data have been submitted and approved.
   3. The energizing and outage schedule has been submitted and approved.

END OF SECTION

SECTION 280513
CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. UTP cabling.
   2. Low-voltage control cabling.
   3. Control-circuit conductors.
   4. Fire alarm wire and cable.
   5. Identification products.

B. Related Requirements:
   1. Section 078400 - Penetration Firestopping: For penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 DEFINITIONS

A. EMI: Electromagnetic interference.

B. IDC: Insulation displacement connector.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

D. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

E. RCDD: Registered Communications Distribution Designer.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of electronic safety and security cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Installation data for UTP and optical-fiber cables as specified in TIA 568.1-D.

B. Shop Drawings:
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   2. Cabling administration drawings and printouts.
   3. Wiring diagrams to show typical wiring schematics, including the following:
      a. Cross-connects.
      b. Patch panels.
      c. Patch cords.
   4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test each pair of UTP cable for open and short circuits.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ADC.
   2. AMP Netconnect; a brand of Tyco Electronics Corporation.
   3. Belden Inc.
   4. Berk-Tek; a Nexans company.
   5. CommScope, Inc.
   6. Draka Cableteq USA.
   7. Genesis Cable Products; Honeywell International, Inc.
   8. Mohawk; a division of Belden Networking, Inc.
   9. Superior Essex Inc.
   10. SYSTIMAX Solutions; a CommScope, Inc. brand.
   11. 3M; Communication Markets Division.

B. Description: 100-ohm, four-pair UTP, covered with a blue thermoplastic jacket.
   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with TIA-568.1-D for performance specifications.
   3. Comply with TIA-568-C.2, Category 6.
   4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
      a. Communications, Plenum Rated: Type CMP or MPP, complying with NFPA 262.

2.3 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ADC.
   2. American Technology Systems Industries, Inc.
   3. AMP Netconnect; a brand of Tyco Electronics Corporation.
   4. Belden Inc.
   5. Dynacom Inc.
   6. Hubbell Incorporated; Hubbell Premise Wiring.
   7. Leviton Commercial Networks Division.
   8. Molex Premise Networks; a division of Molex, Inc.
   9. Panduit Corp.
   10. Siemon.

B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

2.4 CONTROL-VOLTAGE CABLE

A. Paired Cable: NFPA 70, Type CMG.
   1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. One pair, twisted, No. 16 AWG, stranded (19x29)tinned copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with NFPA 262.

2.5 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.

B. Class 2 Control Circuits: Stranded copper, power-limited cable, complying with UL 83, concealed in building finishes.

2.6 FIRE ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Comtran Corporation.
   2. Draka Cableteq USA.
   3. Genesis Cable Products; Honeywell International, Inc.
   4. Pentair
   5. Rockbestos-Suprenant Cable Corp.
   6. West Penn Wire.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than size as recommended by system manufacturer.
   1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
   1. Low-Voltage Circuits: No. 16 AWG, minimum.
   2. Line-Voltage Circuits: No. 12 AWG, minimum.
   3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor[with outer jacket] with red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

E. Electrical Circuit Integrity Cable (CI): Unshielded and sized as recommended by system manufacturer.
   1. Electrical Circuit Integrity Cable (CI): Twisted unshielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 FHIT System No. 28A for a 2-hour survivability rating.
      a. Cable shall be Radix model # CI1640102-0000-15000, 16AWG solid conductor and/or CI14A0702-0000-15000, 14AWG stranded.
      b. UL Listed Cable shall be installed as an assembly routed in EMT conduit w/minimum size of 3/4” throughout as specified in UL 2196 FHIT System No. 28A.
      c. All raceway couplings and supports shall be UL Listed as an assembly per UL 2196 FHIT System No. 28A.

d. Contractor to consult most current UL 1424 and UL 2196 FHIT System No. 28A publication (and any other referenced or relating) for a 2-hour survivability assembly prior to installation and shall consult electrical professional engineer (PE) of record for approved equals.

2.7 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Brady Worldwide, Inc.
   2. HellermannTyton North America.
   3. Kroy LLC.
   4. Panduit Corp.

B. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Section 260553 "Identification for Electrical Systems."

PART 3 EXECUTION

3.1 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for installation of supports for cables.

3.2 WIRING METHOD

A. Install wiring in metal pathways and wireways.
   1. Minimum conduit size shall be 3/4 inch (21 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.
   2. Comply with requirements in Division 28 Section "Pathways for Electronic Safety and Security."
   3. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."

B. Install cable, concealed in accessible ceilings, walls, and floors when possible.

C. Wiring within Enclosures:
   1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
   2. Install lacing bars and distribution spools.
   3. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer.
   4. Install conductors parallel with or at right angles to sides and back of enclosure.
   5. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks.
   6. Mark each terminal according to system's wiring diagrams.
   7. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.

C. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.

D. Install UTP, optical-fiber, and coaxial cables and connecting materials after spaces are complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

E. General Requirements for Cabling:

1. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels. Leave a minimum of 6 inches (150 mm) of slack at outlet terminations and coil loosely into box after termination on outlet fitting.
2. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
3. Maintain minimum cable bending radius during installation and termination of cables.
4. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
5. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
6. Comply with Section 280544 "Sleeves and Sleeve Seals for Electronic Safety and Security Pathways and Cabling."

F. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1525 mm) apart. Cable supports shall be fastened to structural members or floor slabs in accordance with Section 260529 "Hangers and Supports for Electrical Systems."
3. Cable shall not be run in contact with pipes, ducts, or other potentially damaging items. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

G. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 72 inches (1830 mm) long shall be neatly coiled not less than 12 inches (300 mm) in diameter below each feed point.

H. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 FIRE ALARM WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes for Electrical Systems."

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:
1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Type MI permitted. CI cables must be installed in a 2-hour fire-rated shaft or encased in concrete with a 2-hour fire rating.
3. 2-Hour Fire Rated Assemblies: All components of 2-hour rated assembly systems must have the same UL FHIT listing. Submit FHIT listing documentation with shop drawing submittal.
4. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 POWER AND CONTROL-CIRCUIT CONDUCTORS

A. 120-V Power Wiring: Install according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.

B. Minimum Conductor Sizes:
1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.6 CONNECTIONS

A. Comply with requirements in Section 281600 "Intrusion Detection" for connecting, terminating, and identifying wires and cables.

B. Comply with requirements in Section 281300 "Access Control" for connecting, terminating, and identifying wires and cables.

C. Comply with requirements in Section 282350 "IP (Network) Video Surveillance System" for connecting, terminating, and identifying wires and cables.

D. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System" for connecting, terminating, and identifying wires and cables.

3.7 FIRESTOPPING

A. Comply with requirements in Section 078413 "Firestopping."

3.8 GROUNDING

A. For communications wiring, comply with J-STD-607-B and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" chapter.

B. For low-voltage wiring and cabling, comply with requirements in Section 280526 "Grounding and Bonding for Electronic Safety and Security."

3.9 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visually inspect UTP jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568.1-D.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.
    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

SECTION 280528
PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Metal wireways and auxiliary gutters.
   3. Nonmetallic wireways and auxiliary gutters.
   4. Surface pathways.
   5. Boxes, enclosures, and cabinets.

B. Related Requirements:
   1. Section 078400 - Penetration Firestopping: For penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

1.3 SUBMITTALS

A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

C. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of pathway groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

D. Qualification Data: For professional engineer.

E. Source quality-control reports.

PART 2 PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems, Inc.
   2. Allied Tube & Conduit; a Tyco International Ltd. Co.
   3. Anamet Electrical, Inc.
   4. Bridgeport Fittings, Inc.
   5. Electri-Flex Company.
   6. O-Z/Gedney; a brand of EGS Electrical Group.
   7. Picoma Industries; Subsidiary of Mueller Water Products, Inc.
   8. Republic Conduit.
   9. Robroy Industries
   10. Southwire Company.
   11. Thomas & Betts Corporation.

12. Western Tube and Conduit Corporation.
13. Wheatland Tube Company; a division of John Maneely Company.

B. General Requirements for Metal Conduits and Fittings:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-B.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. EMT: Comply with ANSI C80.3 and UL 797.

G. FMC: Comply with UL 1; zinc-coated steel.

H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Fittings for EMT:
      a. Material: Steel or Zinc die cast.
      b. Type: Setscrew or compression.
   2. EMT Fittings Materials:
      a. All Zinc materials shall be ASTM B86 certified
      b. All Zinc Product shall be ZAMAK #3 and/or #7 formula.
      c. All Steel shall be SAE 1050.
   3. EMT Fittings Design:
      a. Zinc die cast components shall be ball burnished.
      b. Steel parts shall be zinc plated for corrosion protection.
      c. All Locknuts shall have a dual, precision machined-cut thread, reversible and possess a serrated face on each side.
      d. All set screw products shall be manufactured with a tri-drive head and staked or modified to prevent disassembly.
      e. All fitting throat diameters shall be smooth with no sharp edges or slag.
      f. Rain tight products shall have internal sealing rings to create and maintain a rain tight seal.
      g. All fittings shall be tested per UL 514B and be listed by Underwriters Laboratories.
   4. Transition Fittings:
      a. All transitions fittings (go-to or from-to fittings) or fittings used to transition from one raceway type to another must be UL listed for that application.

J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper B-Line, Inc.
   2. Hoffman; a Pentair company.
   3. Mono-Systems, Inc.
   4. Square D; a brand of Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
   1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-B.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.3 SURFACE PATHWAYS

A. General Requirements for Surface Pathways:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-B.

B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Prime coated, ready for field painting.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Mono-Systems, Inc.
      b. Niedax-Kleinhuis USA, Inc.
      c. Panduit Corp.
      d. Wiremold / Legrand.

C. Surface Nonmetallic Pathways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Hubbell Incorporated; Wiring Device-Kellems Division.
      b. Lamson & Sessions; Carlon Electrical Products.
      c. Mono-Systems, Inc.
      d. Panduit Corp.
      e. Wiremold / Legrand.

D. Tele-Power Poles:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Mono-Systems, Inc.
      b. Panduit Corp.
      c. Wiremold / Legrand.
   2. Material: Galvanized steel with ivory baked-enamel finish.
   3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Adalet.
   2. Cooper Technologies Company; Cooper Crouse-Hinds.
   3. EGS/Appleton Electric.
   4. Erickson Electrical Equipment Company.
   5. Hoffman; a Pentair company.
   6. Hubbell Incorporated; Killark Division.
   7. Lamson & Sessions; Carlon Electrical Products.
   8. Milbank Manufacturing Co.
   9. Molex, Woodhead Brand
   10. Mono-Systems, Inc.
   11. O-Z/Gedney; a brand of EGS Electrical Group.
   12. RACO; a Hubbell Company.
   13. Robroy Industries.
   14. Spring City Electrical Manufacturing Company.
   15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
   16. Thomas & Betts Corporation.

17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets:
   1. Comply with TIA-569-B.
   2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

F. Metal Floor Boxes:
   1. Material: Cast metal or sheet metal.
   2. Type: Fully adjustable.
   3. Shape: Rectangular.
   4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

I. Device Box Dimensions: 4-inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

J. Gangable boxes are prohibited.

PART 3 EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC or IMC.
   2. Concealed Conduit, Aboveground: EMT.
   3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric-Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   5. Damp or Wet Locations: GRC or IMC.
   6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 3/4-inch (21-mm) trade size. Minimum size for optical-fiber cables is 1 inch (27 mm).

D. Pathway Fittings: Compatible with pathways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
   3. EMT: Use setscrew or compression, steel or Zinc die-cast metal fittings. Comply with NEMA FB 2.10.

4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20 and UL514B.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications wiring conduits for which only two 90-degree bends are allowed. Support within 12 inches (300 mm) of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches (300 mm) of enclosures to which attached.

I. Raceways Within 1 ½" of Roof Deck:
   1. All raceway shall be installed further from 1 ½" of roof deck or raceway shall be RMC or IMC.

J. Stub-ups to Above Recessed Ceilings:
   1. Use EMT, IMC, or RMC for pathways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

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

L. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

N. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to conduit assembly to assure a continuous ground path.

P. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

Q. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.

R. Surface Pathways:
   1. Install surface pathway for surface electrical outlet boxes only where indicated on Drawings.
   2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points.

3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

S. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.

T. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service pathway enters a building or structure.
   3. Where otherwise required by NFPA 70.

U. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

V. Flexible Conduit Connections: Comply with NEMA RV 3. Use maximum of 72 inches (1830 mm) of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

W. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

X. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Y. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Z. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

BB. Set metal floor boxes level and flush with finished floor surface.

CC. Boxes installed in metal stud and sheetrock walls shall have far-side box support.

DD. Boxes shall be secured to metal studs with spring steel clamp which wraps around the entire face of the stud and digs into both sides of the stud. Clamp shall be screwed into the stud.

EE. Set outlet boxes for flush mounted devices to within 1/8” of finished wall.

FF. Minimum box size to be two gang. For installation of single gang device use properly sized mud ring with thickness to install device within 1/8” of finished wall.

GG. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

HH. Firestopping: Provided by Section 078400 - Penetration Firestopping. Coordinate with Section 078400 for sealing of penetrations through fire and smoke barriers.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electronic Safety and Security Pathways and Cabling."

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section “Firestopping."

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION

SECTION 281300
ACCESS CONTROL

PART 1 GENERAL

1.1 APPLICABLE DOCUMENTS

A. The Drawings, the provisions of the Contract, including General and Supplementary Conditions, and the General Requirements apply to the Work of this Section.

B. All Division 26 Sections.

C. Division 27 - Intercommunication and Program Systems.

D. Division 28 - Video Surveillance; Duress Alarm.

1.2 SUMMARY

A. Section includes:

1. Access control system work performed by a qualified security contractor:
   a. Card readers, door contacts, request to exit sensors, electric lock interfaces.
   b. Cabling of access control devices, electric locks, and power door operators and actuators.
   c. Duress alarm interface and power cabling.
   d. Access Control Panels.
   e. Interface and Junction Boxes.
   f. Power Supplies.
   g. Coordination with the Security Integrator.
2. Access control system work performed by the Hennepin County Security System Integrator:
   a. System programming.
   b. Software licenses and workstation configuration.
   c. Smart Relay and Smart Relay programming for integration of power door operators.
   d. Network coordination and connection to the Hennepin County Security Wide Area Network.
   e. Coordination with the Security Contractor.
   f. Integration of Video Surveillance and Intercom Systems.
   g. Contact Information for the Hennepin County Security Integrator:
      VTI Security - Minnesota
      401 West Travelers Trail
      Burnsville, Minnesota 55337
      Voice: 952.894.5343 Fax: 952.894.0509
      Email: vti@vtisecurity.com

1.3 QUALITY ASSURANCE

A. Required Qualifications for the Security System Integrator:
   1. The Security Integrator must be the existing Hennepin County Service Vendor for Andover Access Control Systems, Pelco Video systems, and Stentofon Intercom Systems.

B. Required Qualifications for the Security Contractor:
   1. Security Contractor must have the necessary trained, licensed, and bonded trade and technical persons necessary to perform the tasks required under this specification.
   2. Security technicians shall be licensed as Power Limited Technicians through the Minnesota State Board of Electricity and have successfully completed an accredited, industry related, electronics course.
   3. Security Contractors shall, upon request, submit individual training and/or certification documentation for any service technician providing services under this specification.
   4. Security Contractor must be able to demonstrate that they have had a minimum of three (3) years' experience in the access control field of commercial, institutional and/or industrial facilities (non-residential) within the confines of the thirteen (13) county Minneapolis-St. Paul-Bloomington MN-WI Metropolitan Statistical Area (The MN-WI MSA consists of the counties of Hennepin, Anoka, Carver, Chisago, Dakota, Isanti, Ramsey, Scott, Sherburne, Washington and Wright in Minnesota and Pierce and St. Croix in Wisconsin).

5. The Security Contractor shall furnish a minimum of two (2) customer references within said thirteen (13) county MSA, at least one of which shall be substantially similar in size and scope to these specifications. References maybe from either the public or private sector.
6. Security Contractor, on a 24 hour/7 day per week basis, must be able to respond to emergency service within two (2) hours of an emergency service request.
7. Security Contractor technicians must be factory certified in the Andover Continuum Access Control product line.
8. Security Contractor must employ in-house personnel to maintain and submit electronic record documentation in the most current AutoCAD format to Hennepin County.
9. Security Contractor must employ engineering personnel with factorycertified training in Andover Plain English Programming Language.
10. Security Contractor must currently support at least one (1) Andover Access Control System (in the public or private sector) of substantially similar size and complexity which resides on a wide area network.

1.4 SUBMITTALS

A. Submit per Section 013300.

B. The security contractor shall submit to the engineer all data sheets for components provided by the security contractor. The security integrator shall submit data sheets for components provided by the security integrator. These components are identified in Section 2. The parts list and the corresponding data sheets shall be submitted in the same order in a single PDF file. Multiple PDF files will be rejected.

C. The Security Integrator shall submit all as-built drawings in Autocad format. As-builts shall include:
   1. Floorplans showing symbols for all devices.
   2. Details plans showing wiring terminations to all devices and control equipment and interfaces to other systems such as fire alarm and elevator controls.
   3. Riser diagrams showing interconnection of all devices and control locations.
   4. Schedules noting device types and configuration data.
   5. Elevations of equipment racks.

D. Operator and Maintenance Manuals shall be submitted as electronic documents or media. Hardcopy shall only be submitted if electronic versions are not available.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Package, handle, deliver and store at the job site in a manner that will avoid damage.

B. Provide locked storage units Contractor shall not deliver, store, or install any product in construction areas where the product is subject to damage from water, dust, and construction debris.

1.6 WARRANTY

A. Provide warranty per the general and supplemental conditions of the contract.

PART 2 PRODUCTS

2.1 PRODUCTS

A. The following products are standard products in use throughout Hennepin County facilities. No substitutions are allowed. If a listed product cannot be provided, notify the engineer in writing prior to the final addendum date and an alternative product will be identified.

B. The following products shall be provided by the Security System Integrator:
   1. Andover Continuum Client Workstation Access Control Software.
      a. Provide all software licenses, software, and security keys required for the workstations shown on plans.
      b. Provide all database licenses.
      c. Provide Pinpoint graphics software.
      d. Provide server software license expansion as required.

C. The following products shall be provided by the Security Contractor unless noted otherwise.

1. Card Readers – Wall Mount
   a. Minimum Requirements
      1) Dual Technology Compatible with:
         (a) Hennepin County Indala 125Khz cards.
         (b) Hennepin County HID iClass 13.56 MHz SE cards.
      2) Arch Wallswitch Package.
      3) Black
      4) Weigand Output.
      5) Hennepin County Format with Proprietary Format.
   b. Approved Products
      1) HID Multiclass SE RP40 Series
2. Card Readers – Mullion Mount
   a. Minimum Requirements
      1) Dual Technology Compatible with:
         (a) Hennepin County Indala 125Khz cards.
         (b) Hennepin County HID iClass 13.56 MHz SE cards.
      2) Arch Mullion Package
      3) Black
      4) Weigand Output
      5) Hennepin County Format with Proprietary Format.
   b. Approved Products
      1) HID Multiclass SE RP15 Series
3. Card Readers with Internal Keypad
   a. Minimum Requirements
      1) Dual Technology Compatible with:
         (a) Hennepin County Indala 125Khz cards.
         (b) Hennepin County HID iClass 13.56 MHz SE cards.
      2) Arch Wallswitch Package.
      3) 5" Read Range.
      4) Black.
      5) Wiegand Output.
      6) Hennepin County Format with Proprietary Format.
      7) Internal 9 Keypad.
   b. Approved Products
      1) HID Multiclass SE RPK40 Series.
4. Request to Exit Sensors
   a. Minimum Requirements:
      1) Exit Detector w/Piezo.
      2) Tamper Switch.
      3) Two Relay Outputs.
   b. Approved Products:
      1) Kantech T Rex.
5. Door Contacts
   a. Provide door contacts as shown on plans.
   b. Approved Products:
      1) Recessed - Sentrol, 1078CWBR 3/4" Magnetic Contact Brown Wide Gap.
      2) Bifold \ Overhead Door - Sentrol 2325AL Track Mount Panel Door Contact.
      3) Surface Mount - Sentrol, 2500 Series industrial door contact.
      4) Or Approved Equals.
6. Motion Detectors – 360 Degree.
   a. Minimum Requirements
      1) Physical Dimensions—5" H x 5" W x 2.3" D.
      2) White, high impact, ABS plastic housing.
      3) Weight: 14 oz (397 g).
      4) Power Requirements 10 – 14.5VDC – 40mA, 12VDC typical.
      5) Alarm Relay Energized Form C: (N.O./N.C.) reed relay rated 125mA at 25VDC.
      6) Microwave Frequencies– 10.525 GHz (USA).
      7) Operating Temperature – 32° – 120° F (0° – 49° C); 5% to 95% relative humidity, non-condensing.
      8) RFI Immunity – 30 Vm, from 10 MHz – 1000 MHz.

9) PIR White Light Immunity – 900 LUX.
10) Detection Range – 50' (15m) diameter, 25' (7.6m) radius.
11) PIR Fields of View 8'–11' mirror assembly (three 360° fields)
12) Long range: 36 Lower: 16 Intermediate: 24 Look-down: 1– 12'–16' mirror assembly (two 360° fields)
13) Long range: 40 Intermediate: 20 Look-down: 1.
14) Sensitivity– 2–4 steps within field of view.

b. Approved Products
1) Honeywell DT6360STC.
2) Or Approved Equal.

7. Motion Detectors – Wall Mount
a. Minimum Requirements
1) Physical Dimensions (8" x 6-1/2" x 6").
2) Alarm Relay Energized Form C; 25VDC, 125 mA 22 ohm series protection resistor, 30VDC, 25 mA (N.C.).
3) Power Requirement 10–15VDC; 50 mA (max) at 12VDC.
4) Operating Temperature 0° to 49° C (32° to 120° F); 5% to 95% relative humidity, non-condensing.
5) PIR White Light Immunity 6500 LUX.
6) RFI Immunity 30 V/m, 10 MHz to 1000 MHz.
7) Optimal Mounting Height Range 2m (6') minimum to (12') maximum.
8) Microwave Frequency X-Band.
9) ESD Immunity +10 kV.
10) Approvals/Listings – UL
(a) ULC
(b) CE
(c) C-Tick
(d) EN50131-I Grade 3, Class II.
11) Approved Products
(a) Honeywell DT901 Or Approved Equal.

8. Keypads – Arming and Status Display
a. Minimum Requirements
1) Keypad Inputs: 19 buttons, 4 x 4 matrix, including UP, DOWN, ENTER, and CANCEL; plus 3 additional function keys, all backlit.
2) Display Outputs: 4 x 16 LCD, backlit.
3) Audible Beeper Output: Yes.
4) LED Indicators: 2: one Red, one Green, programmable operation.
5) Operating Environment: 32°–120 °F (0–49°C), 0–95% RH (non-condensing).
6) Mounting: Mount on a vertical surface.
7) Enclosure: Polymetric, UL-94V-0 Flame Rating, IP30.
8) Dimensions: 4.65” H x 6.04” W x 1.49” D.

b. Approved Products
1) Andover LD-1.

9. Access Control Junction Box
a. Refer to detail drawings for box configuration.
b. Provide smart relay system and program at door locations requiring an interface to power door operators.
c. Configure junction box to include the following components as required. Provide all components and interconnections for a complete and operational system.
1) NEMA 4 Enclosure with Perf Panel.
2) IDEC Smart Relay with memory module (Where required for power door operators, the security integrator shall provide a programmed smart relay to the security contractor and coordinate on installation).
3) Wago Terminal Blocks.

10. Elevator Control Demarcation Box
a. Minimum Requirements
1) Refer to detail drawings for box configuration.
2) Configure junction box to include the following components as required. Provide all components and interconnections for a complete and operational system.
(a) Provide NEMA 4 Enclosure with Perf Panel.

(b) Provide DIN Rail socket mounted relays.
(c) Provide Wago Terminal Blocks.
(d) Fail Safe Override Switch.

3) Relays
(a) UL Listed
(b) DPDT Contact Arrangement.
(c) 24VDC Coil Voltage.
(d) Mechanical Life: 30,000,000 DC Operations.
(e) LED Indicator.
(f) Latching Lever.
(g) Momentary Check Button.
(h) DIN Rail Socket.
(i) DC Coil Suppression Diode.

4) Approved Manufacturers
(a) IDEC RU Series or Approved Equal.

11. Access Control Panel
a. Minimum Requirements
1) Configure Panel to include the following components as required. Provide all components and interconnections for a complete and operational system. Refer to detail pages for assembly information.
2) Determine the number of panels, modules, and power suppliers per the access control devices shown on plans.
b. Approved Products
a. Andover Continuum AC-1 access control modules (Per controlled doors as shown on plans).
b. Andover NetController II, 0 Nodes, RS-485 I/O Bus.
c. Andover Continuum UI-8, 10 bit resolution, 5V input module.
d. Andover Continuum DO-4-R-) w/3 position overide switches.
e. Andover Continuum PS120/240-AC85U.
f. Andover Continuum Battery (12V, 6.5 Ahr battery).
g. Kele 36x26x7 NEMA 1 Enclosure UL w/Perf Panel.

12. Power Supplies 24VDC
a. Minimum Requirements
1) Contractor shall review door hardware schedules and provide lock power supplies where not provided in the lock hardware groups. Size and quantities are to be determined by this contractor.
2) Network Monitoring Functions:
(a) DC Output Voltage.
(b) Output Current Draw.
(c) AC Status.
(d) Battery Status.
(e) Unit Temperature.
b. Approved Products
1) Altronix eflow series with built in ACM module and LINQ2.

13. Power Supplies 12VDC Auxiliary Supplies
a. Minimum Requirements
1) Provide auxiliary power supplies to power motion detectors, alarms, controls, and duress alarm receivers. Size and quantities are to be determined by this contractor.
2) Network Monitoring Functions:
(a) DC Output Voltage.
(b) Output Current Draw.
(c) AC Status.
(d) Battery Status.
(e) Unit Temperature.
b. Approved Products
1) Altronix eflow series with built in ACM module and LINQ2.

14. Cabling
a. Refer to cable types shown on the schematic detail.
b. Provide plenum rated cable unless noted otherwise.

c. Fiber and CAT6 cabling shall be provided by the Network cabling contractor unless noted otherwise.
d. Provide all other cables as required for a complete and operational system.
e. Install per ANSI/TIA 568 and 569 Provide J Hook cable supports for all cabling.
f. Where basket tray is provided for low voltage cabling, install cabling in the partition designated for the access control system.

PART 3 EXECUTION

3.1 INSTALLATION AND OPERATIONAL REQUIREMENTS FOR THE SECURITY INTEGRATOR

A. Coordination with the Security Contractor
1. The Security Integrator shall provide all addressing and naming requirements to the Security Contractor.
2. The Security Integrator shall meet with the security contractor to hand off the installed devices for integration into the County system. (See contractor handoff requirements).

B. Network Connections
1. Coordinate with Hennepin County IT to:
a. Establish network connections to the Security VLAN.
b. Define IP address requirements.

C. Local Workstations
1. Provide graphical control and status annunciation for:
a. Access Control Devices.
b. Intercoms.
c. Duress Alarms.
d. Video Cameras.
e. Vehicle Gates.
f. Overhead Garage Doors.
2. Provide Andover Video Monitor software and programming to allow viewing of live and recorded digital video.
3. Provide Video Monitor calls for door alarms, intercom call, and motion detection alarms.

D. System Programming – Hennepin County Security Operations Center (SOC).
1. The system will be monitored and controlled at the Hennepin County SOC.
2. Modify the system graphics at each workstation per Hennepin County Standards to sup ort control and monitoring of all devices including but not limited to:
a. Card Reader Doors
b. Monitored Doors
c. Controlled Doors
d. Cameras
e. Intercoms
f. Duress Alarms.
3. Per Hennepin County Standards, integrate the video system to associated video clips with alarm events for:
a. Duress Alarms
b. Intercom Calls
c. Door Alarms
d. Card Reads.

E. Card Reader Doors
1. Coordinate with Owner to define:
a. Access control clearance and cardholder privileges.
b. Door Lock \ Unlock schedules.
c. Naming Conventions.
d. Submit written programming plan for owner approval prior to any system programming.
2. Program all scheduled lock times and holiday schedules.
3. Provide card holder image display lookup and link to access control activity such as valid card reads.

4. Program propped and forced door alarms for each monitored door. Annunciate alarms on local workstation graphics.
5. Card reader LED shall function as:
    a. Green = Unlocked
    b. Red = Locked
    c. Flashing = Alarm
6. Request to exit sensor shall shunt alarms on valid egress.
7. Request to exit sensors shall not unlock doors.
8. Request to exit sensor shall sound internal pie o alarm during propped or forced door alarms. Sounder shall clear once the door is returned to closed. Use of the sounder shall be programmable per door. Software design shall allow the security supervisor to enable\disable the sounder.

F. Integration with Power Door Operators
    1. The security integrator shall review the electronic locking hardware and provide a pro rammed smart relay to meet the following requirements:
        a. Disable the exterior actuator when the door is locked.
        b. Generate a request to exit signal to the access control system when the interior actuator is pressed to prevent false alarms when exiting.
        c. Delay door operator opening until electronic latch is released to prevent binding.
        d. Normal power door operation will require a valid card read followed by pressing the exterior actuator.
        e. Where specifically programmed per card holder, presenting a valid card shall unlock the door and activate the power door operator.

G. Bifold Garage Door and Overhead Garage Door
    1. Provide the following status information on Andover Graphics Propped door alarm Door open/closed status

H. Lockdown
    1. Provide a lockdown icon to enable\disable lockdown mode.
    2. During lockdown:
        a. Lock all controllable doors and restrict card holder access as directed by the Owner.

I. Program the Card Reader Keypad and LD-1 Arming\Disarming Keypads.
    1. Motion detection zones shall be armed on the LD-1. Coordinate with the owner to determine if a single button or a code will be required for arming. Indicate the arming disarming status on the LD-1 Keypad.
    2. Motion detection zones shall be disarmed by the Card Reader keypad. A valid card read from designated cardholders and a keypad code shall be required for disarming. The associated door shall not unlock until the motion detection zone is disarmed.
    3. Coordinate codes with the owner and provide a means of revising codes through the Andover Continuum software.

J. Elevator Control
    1. The Security Integrator shall coordinate with the Elevator Contractor and the Security Contractor to define relay assignments, wire terminations, and programming of floor control relays.
    2. Program the system to provide elevator floor by floor access control.
    3. Do not provide a floor control relay for the street level floor. Access to this floor shall be unrestricted at all times.
    4. During secured hours:
        a. Close the “Secure\Unsecure Mode” relay.
        b. Close the floor control relays to secure each controlled floor.
        c. When a valid credential is presented, momentarily open the associated floor re ay(s) to allow access to the cardholders authorized floor(s). Coordinate the required time period for an open relay with the elevator contractor.

K. Power Supplies
    1. The Security Integrator shall configure the monitoring software for power supplies.

3.2 INSTALLATION AND OPERATIONAL REQUIREMENTS FOR THE SECURITY CONTRACTOR

A. Coordination with the Security Integrator
   1. The Security Contractor shall install and test all field devices and control panels prior to integration with the County system.
   2. The Security Contractor shall provide all temporary software and temporary PC's required to demonstrate control and status of the field devices.
   3. Once tested, the Security Contractor shall demonstrate proper operation of the devices and handoff the system to the Security Integrator.

B. Card Access Devices
   1. Coordinate final reader location with owner prior to electrical rough in.
   2. Provide termination and wiring to electrified locking devices and power door operator controls. Coordinate with door hardware supplier to test and troubleshoot lock hardware.
   3. Provide card access junction box on the secure side of access control doors.
   4. Provide transient protection for exterior card readers

C. Access Control Panels
   1. Coordinate wall space and equipment locations with other contractors.
   2. Provide cable management within enclosure.
   3. Provide wire duct or conduit for all wiring coming from accessible ceiling or between enclosures.

D. Building Entrance Points and Gate Integration Enclosures.
   1. A building entrance point enclosure shall be provided by the electrical contractor where shown on plans Coordinate location of devices with the associated contractors. Refer to detail drawings.

E. Elevator Controls
   1. Provide the Elevator Control Demarcation boxes as shown on plans.
   2. Configure the relays to indicate a picked condition (LED ON) when the relay is closed.
   3. Label all terminal blocks and coordinate wire terminations with the Elevator Contractor and the Security Integrator.
   4. Provide a switch inside the demarcation box to drop all relays and place the elevator in unsecure mode. Label the switch positions.
   5. Wire the associated access control panel to be fail safe. Loss of power to the Access Control Panel shall place the elevator in Unsecure mode. Open contacts from the Access Control panel shall place the elevator in Unsecure mode.
   6. All controls defined above are considered secondary and shall not override any life safety controls provided by the Elevator Controller.
   7. Clearly label the elevator demarcation box to match the riser diagram designators and mount in a serviceable location.

F. Cabling
   1. Provide cable supports for all access control cable Access control cabling shall not be routed in cable trays provided for data communications unless.

G. Cabling for the Duress Alarm System
   1. Coordinate with the Duress Alarm Contractor. All Duress Alarm cabling shall be provided by the Access Control Security Contractor.

H. Labeling
   1. All labels shall be machine printed white background black letter labels with permanent ink and permanent adhesive.
   2. Handwritten labels are not acceptable at any locations.
   3. All equipment, cabinets, and junction boxes shall be labeled to match the designators shown on a corresponding as-built riser wiring diagram.
   4. Each cable shall be labeled at all terminations points to match a corresponding as-built wiring diagram. Labeling is not required for interconnections within an enclosure or assembly.
   5. Submit a labeling plan to the owner prior to label installation.

I. Transient Protection
   1. Provide Transient Protection devices for all copper conductors entering the facility from exterior locations.

J. Life Safety Interface
   1. Coordinate the connection of the Life Safety Relay to the Lock Power Supply.
   2. Provide fail safe (not a software function) wiring for all door locks described as Fail Safe or Non Fail Secure by in Section 087100 Door Hardware.

K. Supervisory Alarms
   1. Provide interconnection and annunciate supervisory alarms at the Hennepin County Security Operations Center for:
      a. Access Control Panel Tamper Power Supply Supervisory Alarms

3.3 TRAINING

A. The Security Integrator shall provide a minimum of 3 training sessions. Each session shall last a minimum of two hours.
   1. Training shall include:
      a. Operator Training – Use of the controls.
      b. Building Engineer Training – Review installation, As-Built's, and Maintenance.

3.4 PROJECT CLOSEOUT

A. The Security Integrator shall conduct a final acceptance test with the Owner and Engineer after all system testing is complete and as built documentation has been submitted.
   1. Upon completion of the above items and all requirements identified in the plans and specifications:
      a. Notify the engineer in writing and request final acceptance.
      b. Conduct an on-site demonstration to the engineer of system performance and compliance with the plans and specifications.
   2. Correct any items noted by the engineer during acceptance and submit a signed punch list of corrections made.
   3. The Security Integrator shall conduct the final acceptance test and provide all submittals below.
   4. System Testing - Each door shall be tested in sequential order and a corresponding written test report shall be submitted to the engineer. Test each door and each of the following conditions in this order:
      a. Normal Card Read with and without ADA Actuator – No Alarms.
      b. Normal Egress with and without ADA Actuator – No Alarms, adjust RTE sensors to eliminate false alarms.
      c. Door Release Button – No Alarms.
      d. Prop Door – workstation alarm, local audible.
      e. Forced Door – workstation alarm, local audible.
   5. Lockdown – Verify all doors lock in the lockdown group.
   6. Life Safety Interface – Verify all doors open in the failsafe group.
   7. Power Down – Verify all panels remain operational during power down.

B. The Security Contractor shall attend the final acceptance test and make repairs as identified by the Engineer.

END OF SECTION

SECTION 281600
INTRUSION DETECTION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Intrusion detection with communication links to perform monitoring, alarm, and control functions.
   2. Integration of other electronic and electrical systems and equipment.

B. Related Sections:
   1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cabling between master control units and field-mounted devices and control units.
   2. Section 281643 "Perimeter Security Systems" for outdoor intrusion detection devices, including lighting and communications associated with chain-link fence gates.
   3. Section 282300 "Video Surveillance" for CCTV cameras that are used as devices for video motion detection.

1.2 DEFINITIONS

A. CCTV: Closed-circuit television.

B. PIR: Passive infrared.

C. RFI: Radio-frequency interference.

D. UPS: Uninterruptible power supply.

E. Control Unit: System component that monitors inputs and controls outputs through various circuits.

F. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

G. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.

H. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.

I. Standard Intruder: A person who weighs 100 lb (45 kg) or less and whose height is 60 inches (1525 mm) or less; dressed in a long-sleeved shirt, slacks, and shoes unless environmental conditions at the site require protective clothing.

J. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

K. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.

L. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.3 ACTION SUBMITTALS

A. Product Data: Components for sensing, detecting[, systems integration], and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.
   1. Provide coversheet indicating project title, project location, and vendor contact information.

2. Organize submittal into logical sections and provide table of contents.
3. Provide itemized bill of materials indicating model number and quantity for each product.
4. On datasheets with multiple products, indicate which product is provided under this project.
5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
7. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify programmable logic controllers and control interface devices and media to be used. Describe characteristics of network and other data communication lines.
    a. Indicate methods used to achieve systems integration.
    b. Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
    c. Describe characteristics of network and other data communication lines.
    d. Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.
8. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection and for systems integration. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.
9. UPS: Sizing calculations.
10. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building. Include room layout for master control-unit console, terminal cabinet, racks, and UPS.
11. Master Control-Unit Console Layout: Show required artwork and device identification.
12. Device Address List: Coordinate with final system programming.
13. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
14. Details of surge-protection devices and their installation.
15. Sensor detection patterns and adjustment ranges.

C. Design Data: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Field quality-control reports.
    1. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

C. Product Warranty: Sample of special warranty.

D. Field Test Reports: Test plan defining all tests required to ensure that system meets technical, operational, and performance specifications within 60 days of date of Contract award.

E. Evaluation Reports: Examination reports documenting inspections of substrates, areas, and conditions.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Data for each type of product, including features and operating sequences, both automatic and manual.
2. Master control-unit hardware and software data.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Intrusion Detection Devices: Furnish quantity equal to five percent of the number of units of each type installed, but no fewer than one of each type.
   2. Fuses: Three of each kind and size.
   3. Tool Kit: Provide six sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.
   4. Security Fasteners: Furnish no fewer than 1 box for every 50 boxes or fraction thereof, of each type and size of security fastener installed.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:
   1. An employer of workers, at least one of whom is a technician certified by the National Burglar & Fire Alarm Association.
   2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Intrusion Detection Systems Integrator Qualifications: An experienced intrusion detection equipment supplier[and Installer] who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

C. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Control Units, Devices, and Communications with Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.

F. FM Global Compliance: FM-Approved and -labeled intrusion detection devices and equipment.

G. Comply with NFPA 70.

1.8 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
   1. Altitude: Sea level to 4000 feet (1220 m).
   2. Master Control Unit: Rated for continuous operation in an ambient of 60 to 85 deg F (16 to 29 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
   3. Interior, Controlled Environment: System components, except master control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambients of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
   4. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambients of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
   5. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambients of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Description: [Hard-wired] [Multiplexed], modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.

B. Supervision: System components shall be continuously monitored for normal, alarm, [supervisory,]and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.
   1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
   2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
   3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.

C. System Control: Master control unit shall directly monitor intrusion detection units and connecting wiring.

D. System Control: Master control unit shall directly monitor intrusion detection devices, perimeter detection units, and connecting wiring in a multiplexed distributed control system or as part of a network.

E. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.

F. Operator Commands:
   1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
   2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
   3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
   4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
   5. Protected Zone Test: Initiate operational test of a specific protected zone.
   6. System Test: Initiate system-wide operational test.
   7. Print reports.

G. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.

H. Automatic Control of Related Systems: Alarm or supervisory signals from certain intrusion detection devices control the following functions in related systems:
   1. Switch selected lights.
   2. Shift elevator control to a different mode.
   3. Open a signal path between certain intercommunication stations.
   4. Shift sound system to "listening mode" and open a signal path to certain system speakers.
   5. Switch signal to selected monitor from CCTV camera in vicinity of sensor signaling an alarm.
   6. <Insert description of automatic control required>.

I. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When master control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands shall initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.

J. Response Time: Two seconds between actuation of any alarm and its indication at master control unit.

K. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

L. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.

M. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

2.2 SYSTEM COMPONENT REQUIREMENTS

A. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit shall be selected and configured with accessories for full compatibility with the following equipment:
   1. Lighting controls specified in Section 260923 "Lighting Control Devices."
   2. Access control system specified in Section 281300 "Access Control."
   3. Fire alarm system specified in Section 283111 "Digital, Addressable Fire-Alarm System."
   4. Video surveillance system specified in Section 282350 "Network Video Surveillance."

B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
   1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
   2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

C. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.

D. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.

E. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display shall identify tamper alarms and indicate locations.

F. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.

G. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.

H. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master control unit.

I. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

2.3 ENCLOSURES

A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.

B. Interior Electronics: NEMA 250, Type 12.

C. Exterior Electronics: NEMA 250, Type 4X, fiberglass.

D. Corrosion Resistant: NEMA 250, Type 4X, PVC.

E. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

2.4 SECURE AND ACCESS DEVICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Bosch Security Systems, Inc.
2. Corby Industries, Inc.
3. Crow Electronic Engineering, Inc.
4. DAQ Electronics, Inc.
5. Digital Security Controls Ltd.; a business unit of Tyco Safety Products.
6. Edwards Signaling & Security Systems; part of GE Security.
7. Honeywell International Inc.; Honeywell Security.
8. Visonic Inc.

B. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

C. Key-Operated Switch: Change protected zone between secure and access conditions.

2.5 DOOR AND WINDOW SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Aleph America Corporation.
2. General Electric Company; GE Security, Inc.
3. George Risk Industries.
4. Honeywell International Inc.; Honeywell Security.
5. Honeywell International Inc.; Honeywell Video Systems.
6. Optex Inc.
7. Potter Electric Signal, LLC.

B. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of two encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.

C. Flush-Mounted Switches: Unobtrusive and flush with surface of door and window frame.

D. Overhead Door Switch: Balanced-magnetic type, listed for outdoor locations, and having door-mounted magnet and floor-mounted switch unit.

E. Remote Test: Simulate movement of actuating magnet from master control unit.

2.6 PIR SENSORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Aleph America Corporation.
   2. Bosch Security Systems, Inc.
   3. Crow Electronic Engineering, Inc.
   4. Digital Security Controls Ltd.; a business unit of Tyco Safety Products.
   5. General Electric Company; GE Security, Inc.
   6. Honeywell International Inc.; Honeywell Security.
   7. Visonic Inc.

B. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.

C. Description: Sensors detect intrusion by monitoring infrared wavelengths emitted from a human body within their protected zone and by being insensitive to general thermal variations.
   1. Wall-Mounted Unit Maximum Detection Range: 125 percent of indicated distance for individual units and not less than 50 feet (15 m). Provide adjustable coverage pattern as indicated.
   2. Ceiling-Mounted Unit Spot-Detection Pattern: Full 360-degree conical.
   3. Ceiling-Mounted Unit Pattern Size: 84-inch (2135-mm) diameter at floor level for units mounted 96 inches (2440 mm) above floor; 18-foot (5.5-m) diameter at floor level for units mounted 25 feet (7.6 m) above floor.

D. Device Performance:
   1. Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F (1 deg C) or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s) across two adjacent segments of detector's field of view.
   2. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator shall light when sensor detects an intruder. Locate test enabling switch under sensor housing cover.
   3. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

2.7 MICROWAVE INTRUSION DETECTORS (INTERIOR)

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Bosch Security Systems, Inc.
   2. Crow Electronic Engineering, Inc.
   3. Digital Security Controls Ltd.; a business unit of Tyco Safety Products.
   4. General Electric Company; GE Security, Inc.
   5. Visonic Inc.

B. Device Performance: Microwave transmitter establishes an electromagnetic field in an adjustable detection pattern and detects intrusion by monitoring changes in that pattern.
   1. Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s). Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
   2. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test-enabling switch under sensor housing cover.
   3. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

2.8 ACOUSTIC-TYPE, GLASS-BREAK SENSORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Crow Electronic Engineering, Inc.

2. Digital Security Controls Ltd.; a business unit of Tyco Safety Products.
3. General Electric Company; GE Security, Inc.
4. Honeywell International Inc.; Honeywell Security.
5. International Electronics, Inc.
6. Potter Electric Signal, LLC.
7. Visonic Inc.

B. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.

C. Device Performance: Detect unique, airborne acoustic energy spectrum caused by breaking glass.
1. Sensor Element: Microprocessor-based, digital device to detect breakage of plate, laminate, tempered, and wired glass while rejecting common causes of false alarms. Detection pattern shall be at least a 20-foot (6-m) range.
2. Hookup Cable: Factory installed, not less than 72 inches (1830 mm).
3. Activation Indicator: LED on sensor housing that lights when responding to vibrations, remaining on until manually reset at sensor control unit[or at master control unit].
4. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
5. Glass-Break Simulator: A device to induce frequencies into protected glass pane that simulate breaking glass without causing damage to glass.

2.9 PIEZOELECTRIC-TYPE, GLASS-BREAK SENSORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. General Electric Company; GE Security, Inc.
2. Honeywell International Inc.; Honeywell Security.
3. Potter Electric Signal, LLC.
4. Visonic Inc.

B. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.

C. Device Performance: Detect unique, high-frequency vibrations caused by breaking glass.
1. Sensor Element: Piezoelectric crystals in a housing designed to mount directly to glass surface with adhesive provided by element manufacturer. Circular detection pattern, with at least a 60-inch (1525-mm) radius on a continuous glass pane. Sensor element shall not be larger than 4 sq. in. (25.80 sq. cm).
2. Hookup Cable: Factory installed, not less than 72 inches (1830 mm).
3. Activation Indicator: LED on sensor housing that lights when responding to vibrations, remaining on until manually reset at sensor control unit[or at master control unit].
4. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
5. Glass-Break Simulator: A device to induce frequencies into protected glass pane that simulate breaking glass without causing damage to glass.

2.10 VIBRATION SENSORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. General Electric Company; GE Security, Inc.
2. Honeywell International Inc.; Honeywell Security.
3. Potter Electric Signal, LLC.

B. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.

C. Description: A sensor control unit and piezoelectric crystal sensor elements that are designed to be rigidly mounted to structure being protected.

D. Device Performance: Detects high-frequency vibrations generated by use of such tools as oxyacetylene torches, oxygen lances, high-speed drills and saws, and explosives that penetrate a structure while not responding to any other mechanical vibration.
1. Circular detection pattern, with at least a 72-inch (1830-mm) radius on protected structure.
2. Hookup Cable: Factory installed, not less than 72 inches (1830 mm).

3. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
4. Glass-Break Simulator: A device to induce frequencies to protected glass pane that simulate breaking glass without causing damage to glass.

2.11 PHOTOELECTRIC SENSORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Aleph America Corporation.
   2. General Electric Company; GE Security, Inc.
   3. Honeywell International Inc.; Honeywell Security.
   4. Optex Inc.
   5. Potter Electric Signal, LLC.

B. Device Performance: Detect an interruption of a pulsed, infrared, light beam that links transmitter and receiver.
   1. Sensitivity: Detect standard-intruder movement within sensor's detection patterns at any speed of less than 7.5 fps (2.3 m/s) though the beam. Allow installation of multiple sensors within same protected zone that will not interfere with each other.
   2. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
   3. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

2.12 MICROWAVE-PIR DUAL-TECHNOLOGY SENSORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Bosch Security
   2. Honeywell International Inc.; Honeywell Security.
   3. Interlogix
   4. Securitron
   5. Visonic Inc.

B. Description: Single unit combining a sensor that detects changes in microwave signals and a PIR sensor that detects changes in ambient level of infrared emissions caused by standard-intruder movement within detection pattern.

C. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.

D. Device Performance: An alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.
   1. Minimum Detection Pattern: A room 20 by 30 feet (6 by 9 m).
   2. PIR Sensor Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F (1 deg C) or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s) across two adjacent segments of detector's field of view.
   3. Microwave Sensor Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s). Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
   4. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
   5. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

2.13 PERIMETER INTRUSION DETECTION SENSOR

A. Provide intrusion detection sensor with narrow beam angle that uses transmitter/receiver pairs to detect

B. Sensors shall be hardwired for power and signal connections.

C. Sensor shall have the capability of discriminating between people and other elements that cross the beam path.

D. System shall be designed for outdoor use, rated for -35F to 140F use with minimum IP65 ingress protection.

E. Provide all mounting hardware as required. Coordinate exact mounting hardware finish and aesthetic with Architectural prior to ordering.

F. Beam detector transmitter/receiver pairs shall provide a relay output signal to the access control system and shall generate an afterhours alarm. Coordinate system programming with the Owner.

G. Manufacturer: Provide Optex SL-200QDM, SL-350QDM, or SL-650QDM, as required to span distance between transmitter and receivers.

2.14 BURIED CABLE PERIMETER DETECTION SYSTEM

A. Provide buried cable perimeter detection system for detecting people entering the site property boundary as defined on plan. Refer to perimeter detection system schematic diagram for connections to the Owner's Access Control System. Coordinate with the Owner to determine exact detection zones.

B. Performance Requirements:

1. The buried cable system shall be designed to detect intruders within the invisible electromagnetic field created around and between two parallel buried cables, and subsequently identify the precise point of intrusion to within 3 meters (10 ft).
2. Each Control Processor shall monitor up to two buried sensor cable sets for a total perimeter length up to 400 meters (1,312 ft). Southwest Microwave MicroTrack II Processor (MTP II) used as basis of design.
3. The buried cable system shall detect and locate intruders using ultra wide-band Frequency Stepped / Pulse Code Modulated (FS/PCM) technology in conjunction with analysis technology which enables each sensor cable to be divided into small cells, each a maximum of 6.6 feet (2.0 meters) in length, to be independently adapted to site conditions and analyzed. The FS/PCM and MSTA functions shall reside in the distributed Control Processor and not in a centralized processor or computer.
4. The length of each zone in the system shall not be restricted to the physical location of the fixed Control Processor and the sensor cable set lengths, but shall be variable between 3 meters (10 ft) and the maximum zone length as indicated elsewhere in the specifications or project drawings.
5. The buried cable system shall provide sensitivity adjustments which automatically and directly compensate for burial medium variations, equalizing sensitivity to intrusions along its entire length. Sensitivity adjustment is a calibration technique which sets thresholds for each and every cell along the sensor cable.
6. The buried cable system shall allow zones to be established in software independent of the fixed Control Processor locations and sensor cable set lengths.
7. Each buried cable processor shall be capable of supporting up to 190 detection zones independent of the location of the Control Processor.
8. The buried cable system shall employ RF FMCW (Frequency-Modulated Continuous Wave) to detect and locate intruders crossing or walking within the invisible detection field while rejecting small animals and environmental disturbances such as wind, rain, snow, seismic vibration or magnetic effects.
9. The system shall allow for the disabling in software of any section of the sensor cable (gate areas, lead in cables, etc.) eliminating the necessity for spliced non-sensitive cable.
10. The buried cable system shall operate in and under a wide variety of burial media including dry, frozen, snow covered and moisture-saturated sand or soil, as well as concrete, asphalt, and gravel.

11. The buried cable system shall detect walking intruders with a weight of 34 kilograms (75 lbs) with a Probability of Detection (Pd) of 95% at a 99% confidence level.
12. The buried cable system shall have a velocity response ranging from 0.03 meters/sec to 15 meters/sec (0.1 feet/sec to 50 feet/sec) for detecting intruders moving through the detection field.
13. The buried cable system shall not detect small animals weighing 10 kilograms (22 lbs) or less.
14. The buried cable system shall operate at frequencies below 25Mhz to assure that the detection field follows bends or has a minimum of 2 meter radius in the sensor cable to fit site terrain.
15. Each buried cable system shall be capable of supporting up to 190 detection zones per Control Processor independent of the location of the Control Processor.
16. The sensitivity adjustment function shall be calibrated with the use of system software and automatically calibrated for every subcell along the cable.
17. Partitioning of the perimeter area into detection zones shall be established in software after installation of the system and in consideration of site conditions. Considerations for zoning shall include the reduction of nuisance alarms and assessment advantages for patrol personnel.
18. The buried cable system input power shall be capable of accepting standard DC voltage power supplies of 12, 24 or 48 VDC power. The system shall allow for DC power input from 10.5 to 60 VDC.

C. Sensor Cabling Requirements:
1. Sensor cable assemblies shall be available in lengths of 110 meters (360 ft) and 210 meters (689 ft), which includes 5 meters (16 ft) for detection field startup, and have 20 meters (66 ft) of non-sensitive (non-leaky) lead-in cable to connect to the Control Processor. Lead-in cable connectors and cable junctions shall be factory installed.
2. Sensor cable may be cut to length in the field up to a maximum of 210 meters (689 ft). Buried sensor cable connections to end-of-line termination unit or in-line termination unit shall be made with factory provided kits. Standard electrical connectors (e.g., TNC or N-type) and heat shrinkable tubing shall not be used for buried cable connections. MicroTrack™ Terminations (MTT) used as basis of design end-of-line termination unit. MicroTrack™ In-line Terminations (MTI) used as basis of design in-line termination unit.
3. The sensor cable shall be buried to a depth not exceeding 23 centimeters (9 in) in soil, and as determined by the manufacturer for concrete and asphalt for this project.
4. The sensor cable shall not be graded and will be of identical internal construction and dimensions from end to end so repairs do not require analysis of damaged cable.
5. The sensor cable shall be field-repairable if damaged by replacing the damaged section with a spare sensor cable section and a splice kit with encapsulating compound and an enclosure.

D. Control Processor Requirements:
1. Detection processing shall be performed by the various Control Processors distributed around the perimeter. Each Control Processor shall provide processing for up to 400 meters (1,312 ft) of perimeter. Refer to plans for exact Control Processor quantity and location.
2. Detection criteria shall reside in non-volatile memory in each respective Control Processor.
3. Positioning of the Control Processor shall be determined by such factors as perimeter length, operational convenience, and physical security concerns. Positioning of Control Processor shall have no effect on detection zoning.
4. In the event of a temporary loss of communication with the central Controller, each Control Processor shall have the capability of retaining site data until communication is restored.
5. Control Processor shall be hardened to operate within specification at temperatures between
6. -40°C and +70°C (-40°F and +159°F) ambient, without assistance from cooling or heating apparatus.
7. Control Processor shall operate within all specifications when continuously exposed to 0 - 100% relative humidity with conformal coated electronics.
8. Control Processor shall be housed in a weather-tight NEMA 4 enclosure fitted with tamper switches.
9. Control Processor shall include transorb and gas discharge devices to protect against lightning and electrostatic discharge.
10. Control Processor shall be powered directly with 10.5 to 60 VDC.
11. Control Processor shall communicate via RS422 communication of alarms.
12. The Control Processor shall utilize a software-based universal installation tool with graphic display in real time to setup and control sensor parameters with a laptop PC.

13. The Control Processor shall store in memory up to 1,000 alarms and events for troubleshooting and maintenance.
14. Remote adjustment with the manufacturer's software tool will be available via the Processor or direct connection.

2.15 DURESS-ALARM SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. General Electric Company; GE Security, Inc.
   2. Honeywell International Inc.; Honeywell Security.
   3. Visonic Inc.

B. Description: A switch with a shroud over the activating lever that allows an individual to covertly send a duress signal to master control unit, with no visible or audible indication when activated. Switch shall lock in activated position until reset with a key.
   1. Minimum Switch Rating: 50,000 operations.
   2. Foot Rail: Foot activated, floor mounting.
   3. Push Button: Finger activated, suitable for mounting on horizontal or vertical surface.

2.16 VIDEO MOTION SENSORS (INTERIOR)

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Aleph America Corporation.
   2. General Electric Company; GE Security, Inc.
   3. Visonic Inc.

B. Device Performance: Detect changes in video signal within a user-defined protected zone. Provide an alarm output for each video input.
   1. Detect movement within protected zone of standard intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of 2. Reject all other changes in video signal.
   2. Modular design that allows for expansion or modification of number of inputs.
   3. Controls:
      a. Number of detection zones.
      b. Size of detection zones.
      c. Sensitivity of detection of each protected zone.
   4. Mounting: Standard 19-inch (480-mm) rack as described in EIA/ECA 310-E.

2.17 MASTER CONTROL UNIT

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Bosch Security Systems, Inc.
   2. DAQ Electronics, Inc.
   3. Digital Security Controls, Inc.; a business unit of Tyco Safety Products.
   4. General Electric Company; GE Security, Inc.
   5. Honeywell International Inc.; Honeywell Security.
   6. Honeywell International Inc.; Honeywell Video Systems.
   7. Visonic Inc.

B. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.
   1. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
   2. Include a real-time clock for time annotation of events on the event recorder and printer.
   3. Addressable initiation devices that communicate device identity and status.
   4. Control circuits for operation of mechanical equipment in response to an alarm.

C. Construction: Freestanding equipment rack, modular, with separate and independent alarm and supervisory system modules. Alarm-initiating protected zone boards shall be plug-in cards. Arrangements that require removal of field wiring for module replacement are unacceptable.

D. Comply with UL 609.

E. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: LCD, three line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
3. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display and at the system printer.
4. Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.
5. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:
   a. Acknowledge alarm.
   b. Silence alarm.
   c. System reset.
   d. LED test.
6. Timing Unit: Solid state, programmable, 365 days.
7. Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their on or off status. Software shall interpret such signals, display equipment status, and initiate failure signals.
8. Alarm Indication: Audible signal sounds and an LED lights at master control unit identifying the addressable detector originating the alarm. Annunciator panel displays a common alarm light and sounds an audible tone.
9. Alarm Indication: Audible signal sounds and a plain-language identification of the addressable detector originating the alarm appears on LCD display at master control unit. Annunciator panel displays a common alarm light and sounds an audible tone.
10. Alarm activation sounds a bell or siren and strobe.

F. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of 25 percent.

G. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.

H. UPS: Comply with Section 263353 "Static Uninterruptible Power Supply." UPS shall be sized to provide a minimum of six hours of master control-unit operation.

I. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch (25 mm) high. Identify, with permanent labels, individual components and modules within cabinets.

J. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.

K. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

2.18 AUDIBLE AND VISUAL ALARM DEVICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Alarm Controls Corporation.
   2. Cooper Wheelock.
   3. Edwards Signaling & Security Systems; part of GE Security.
   4. Honeywell International Inc.; Honeywell Security.
   5. Potter Electric Signal, LLC.

B. Bell: 10 inches (254 mm) in diameter, rated to produce a minimum sound output of 84 dB at 10 feet (3 m) from master control unit.
   1. Enclosure: Weather-resistant steel box equipped with tamper switches on cover and on back of box.

C. Klaxon Weatherproof Motor-Driven Hooter: UL listed, rated to produce a minimum sound output of 120 dB at 3 feet (1 m), plus or minus 3 dB, at a frequency of 470 Hz. Rated for intermittent use: two minutes on and five minutes off.
   1. Designed for use in industrial areas and in high-noise, severe-weather marine environments.

D. Siren: 30-W speaker with siren driver, rated to produce a minimum sound output of 103 dB at 10 feet (3 m) from master control unit.
   1. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.

E. Strobe: Xenon light complying with UL 1638, with a clear polycarbonate lens.
   1. Light Output: 115 cd, minimum.
   2. Flash Rate: 60 per minute.

2.19 SECURITY FASTENERS

A. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Acument Global Technologies North America.
   2. Safety Socket LLC.
   3. Tamper-Pruf Screws.

C. Drive System Types: Pinned Torx-Plus.

D. Socket Flat Countersunk Head Fasteners:
   1. Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
   2. Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.

E. Socket Button Head Fasteners:
   1. Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
   2. Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.

F. Socket Head Cap Fasteners:
   1. Heat-treated alloy steel, ASTM A 574 (ASTM A 574M).
   2. Stainless steel, ASTM F 837 (ASTM F 837M), Group 1 CW.

G. Protective Coatings for Heat-Treated Alloy Steel:

1. Zinc chromate, ASTM F 1135, Grade 3 or Grade 4, for exterior applications and interior applications where indicated.
2. Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of intrusion detection.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.

D. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.
   1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.
   2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.

E. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SYSTEM INTEGRATION

A. Integrate intrusion detection system with the following systems and equipment:
   1. Lighting controls.
   2. Access control.
   3. Fire-alarm system.
   4. Video surveillance.

3.3 SYSTEM INSTALLATION

A. Comply with UL 681 and NFPA 731.

B. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

C. Install wall-mounted equipment, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

D. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.
   1. Connect new equipment to existing control panel in existing part of the building.
   2. Connect new equipment to existing monitoring equipment at the Supervising Station.
   3. Expand, modify, and supplement existing control equipment as necessary to extend existing control functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

E. Security Fasteners: Where accessible to inmates, install intrusion detection components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.

3.4 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceways according to Section 260533 "Raceways and Boxes for Electrical Systems." Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Wiring Method: Install wiring in metal raceways according to Section 260533 "Raceways and Boxes for Electrical Systems," except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.

C. Wiring Method: Cable, concealed in accessible ceilings, walls, and floors when possible.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Wires and Cables:
   1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
   2. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
   3. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 280513 "Conductors and Cables for Electronic Safety and Security."
   4. Data and Television Signal Transmission Cables: Install according to Section 280513 "Conductors and Cables for Electronic Safety and Security."

F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

G. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

H. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 260553 "Identification for Electrical Systems."

B. Install instructions frame in a location visible from master control unit.

3.6 GROUNDING

A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.

B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.

D. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

E. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."

1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."

F. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."

G. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose. Visits for this purpose shall be in addition to any required by warranty.

3.9 CYBERSECURITY RISK MITIGATION

A. Refer to specification section 013100, “Project Management and Coordination” for cybersecurity risk mitigation strategy.

B. Coordinate with Owner’s IT Department to restrict external network access to Internet connected system through virtual private network (VPN) connections only.

C. All external transport data shall be routed through encrypted channels with 2048-bit secure sockets layer (SSL).

D. Coordinate with Owner’s IT Department to implement a Web server-based human machine interface (HMI) that relies on IT technologies to secure access and restrict ports that can be opened on the firewall. Coordinate with Owner’s IT Department to restrict access to known IP addresses only.

E. Where building system networks are not physically separate from IT business networks, coordinate with Owner’s IT Department to segregate networked and Internet connected systems from the IT business network using virtual local area network (VLAN) IT technologies to restrict internal attacks/breakdowns.

F. Set unique, cryptographically strong passwords for administrator and user accounts. Default passwords must be changed before systems are connected to the Owner’s network.

G. Collect only the data that is necessary for analytics and optimization.

H. References: As a minimum, adhere to practices described in the following network and cybersecurity standards documents:

1. NIST Special Publication 800-14 – Generally Accepted Principles and Practices for Securing Information Technology Systems.
2. NIST Special Publication 800-54 Revisions 4 – Security and Privacy Controls for Federal Information Systems and Organizations.
3. Defense Security Service Office of the Designated Approving Authority – Master System Security Plan (MSSP) Template for Peer-to-Peer Networks (June 2011, Version 3.0.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

END OF SECTION

SECTION 282300
VIDEO SURVEILLANCE

PART 1 GENERAL

1.1 APPLICABLE DOCUMENTS

A. The Drawings, the provisions of the Contract, including General and Supplementary Conditions, and the General Requirements apply to the Work of this Section.

B. All Division 26 Sections.

C. Division 28 – Access Control; Intercom System.

1.2 SUMMARY

A. Section includes:

1. Video surveillance system work performed by a qualified security contractor:
   a. IP Video Cameras.
   b. Transient Protection.
   c. Coordination with the Security Integrator.
2. Video surveillance system work performed by the Hennepin County Security System Integrator.
   a. Recording Servers.
   b. System programming.
   c. Software licenses and workstation configuration.
   d. Network coordination and connection to the Hennepin County Security Wide Area Network.
   e. Coordination with the Security Contractor.
   f. Integration with Access Control.
   g. Contact Information for the Hennepin County Security Integrator:
      VTI Security - Minnesota
      401 West Travelers Trail
      Burnsville, Minnesota 55337
      Voice: 952.894.5343 Fax: 952.894.0509
      Email: vti@vtisecurity.com

1.3 QUALITY ASSURANCE

A. Required Qualifications for the Security System Integrator

1. The Security Integrator must be the existing Hennepin County Service Vendor for Andover Access Control Systems, Pelco Video systems, and Stentofon Intercom Systems.

B. Required Qualifications for the Security Contractor

1. Security Contractor must have the necessary trained, licensed, and bonded trade and technical persons necessary to perform the tasks required under this specification.
2. Security technicians shall be licensed as Power Limited Technicians through the Minnesota State Board of Electricity and have successfully completed an accredited, industry related, electronics course.
3. Security Contractors shall, upon request, submit individual training and/or certification documentation for any service technician providing services under this specification.
4. Security Contractor must be able to demonstrate that they have had a minimum of three (3) years' experience in the IP video surveillance field of commercial, institutional and/or industrial facilities (non-residential) within the confines of the thirteen (13) county Minneapolis-St. Paul-Bloomington MN-WI Metropolitan Statistical Area (The MN-WI MSA consists of the counties of Hennepin, Anoka, Carver, Chisago, Dakota, Isanti, Ramsey, Scott, Sherburne, Washington and Wright in Minnesota and Pierce and St. Croix in Wisconsin).
5. The Security Contractor shall furnish a minimum of two (2) customer references within said thirteen (13) county MSA, at least one of which shall be substantially similar in size and scope to these specifications. References may be from either the public or private sector.
6. Security Contractor, on a 24 hour/7 day per week basis, must be able to respond to emergency service within two (2) hours of an emergency service request.

7. Security Contractor technicians must be factory certified in the Pelco Digital Sentry and Sarix camera product line.
8. Security Contractor must employ in-house personnel to maintain and submit electronic record documentation in the most current AutoCAD format to Hennepin County.
9. Security Contractor must currently support at least one (1) Pelco Digital Sentry system (in the public or private sector) of substantially similar size and complexity which resides on a wide area network.

1.4 SUBMITTALS

A. Submit per Section 013300.

B. In addition:

1. The security contractor shall submit to the engineer all data sheets for components provided by the security contractor. The security integrator shall submit data sheets for components provided by the security integrator. These components are identified in Section 2. The parts list and the corresponding data sheets shall be submitted in the same order in a single PDF file. Multiple PDF files will be rejected.
2. The Security Integrator shall submit all as-built drawings in Autocad format. As-builts shall include:
   a. Floorplans showing symbols for all devices.
   b. Detail plans showing wiring terminations to all devices and control equipment and interfaces to other systems such as fire alarm and elevator controls.
   c. Riser diagrams showing interconnection of all devices and control locations.
   d. Schedules noting device types and configuration data.
   e. Elevations of equipment racks.
3. Operator and Maintenance Manuals shall be submitted as electronic documents or media. Hardcopy shall only be submitted if electronic versions are not available.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Package, handle, deliver and store at the job site in a manner that will avoid damage.

B. Provide locked storage units.

C. Contractor shall not deliver, store, or install any product in construction areas where the product is subject to damage from water, dust, and construction debris.

1.6 WARRANTY

A. Provide warranty per the general and supplemental conditions of the contract.

PART 2 PRODUCTS

2.1 SURVEILLANCE SYSTEMS

A. The following products are standard products in use throughout Hennepin County facilities. No substitutions are allowed. If a listed product cannot be provided, notify the engineer in writing prior to the final addendum date and an alternative product will be identified.

B. The following products shall be provided by the Security System Integrator.

1. Pelco Digital Sentry VMS Software
   a. Provide all camera and software licenses.
   b. Provide all database licenses.
   c. Provide server soft are license expansion as required.
2. KVM and Monitor
   a. Minimum Requirements
      1) 1U 19” Rack Mountable Pullout.
      2) 8 Ports.
      3) 19” LCD Monitor.
      4) Touch Pad.
      5) Resolution 1440x900.
      6) VGA and Analog Inputs.

b. Approved Products:
1) Belkin F1DC108H
2) Or Approved Equal

3. Pelco Digital Sentry Network Video Recorder – Quantity 4
a. Minimum Requirements
1) Provide a total of 4 Network Video Recorders.
2) Processor Intel® Xeon E3-1275 v3.
3) Operating System Windows 7 Ultimate 64-bit.
4) Internal Memory 16 GB DDR ECC.
5) User Interface DS Control Point.
6) System Drive SSD.
7) Storage Drives 6 x 4 TB, Configure for 20TB RAID 5 plus 1 Hot Spare.
8) USB Ports 3 USB 2.0 ports (1 front, 2 rear).
b. Approved Products
1) Pelco DSSRV2-240RD.
2) Note: Contractor shall provide a full value credit applied to an equivalent Pelco Video Expert Server if the County Security Operations Center can support the new Pelco Video Expert system at the time of server installation.

C. The following products shall be provided by the Security Contractor.
1. Camera Type 1 – Indoor surface or recess fixed – Axis P3225-V Mk II.
a. Minimum Requirements.
2. Camera Type 2 – Outdoor surface or recess fixed – Axis P3225-VE Mk II.
a. Minimum Requirements.
3. Camera Type 3 – Indoor surface or recess PTZ – Axis Q6055.
a. Minimum Requirements.
4. Camera Type 4 – Outdoor surface or recess PTZ – Axis Q6055-E.
a. Minimum Requirements.
5. Exterior PTZ Camera Power Supply.
a. Minimum Requirements
1) Electrical.
2) Input Voltage WCS1-4 100/120/240 VAC, 50/60 .
3) Hz Output Voltage WCS1-4 24/26/28 VAC.
4) Required Input Current 1 A.
5) Output Fuse Ratings 4 A.
6) Input Connectors Screw-type barrier strips.
7) Output Connectors Screw-type barrier strips.
8) Input Wire Size 12–16 gauge solid wire.
9) Output Wire Size WCS1-4 16–20 gauge solid or stranded wire.
(a) General
10) Environment Outdoor.
11) Operating Range –50° to 122°F (–45.56° to 50°C).
12) Construction Aluminum.
13) Finish Gray polyester powder coat.
14) Weight Unit Shipping 6.8 lb (3.1 kg) 8 lb (3.6 kg).
b. Approved Products
1) Pelco WCS1-4
6. Transient Protection – Camera Power Conductors
a. Minimum Requirements
1) UL 497B
2) Minimum Surge Current Capacity: 2,000 Amps per pair.
3) Maximum Continuous Current: 5 Amps.
4) MCOV: 33 Volts.
5) Service Voltage: 24Volts.
6) Ten Year Limited Warranty.
b. Approved Products
1) DTK-1LVLPLV
2) Or Approved Equal.
7. Transient Protection – POE Devices
a. Minimum Requirements

1) Agency Approvals: UL497B.
2) Standards Compliance: CAT5e, EIA/TIA568A, EIA/TIA568B.
3) Connection Method: RJ45 In/Out Pinout: All 8 pins are protected.
4) Data Rate: Gigabit Ethernet.
5) Max Continuous Current: 1.5 Amps.
6) Dissipation: 3,000W/pair (10/1000µs impulse).
7) Protection Modes: Line-Ground (All).
8) Operating Temperature: -40°F - 158°F (-40°C - 70°C).
9) Maximum Humidity: 95% non-condensing.
10) Dimensions: 1.7" x 3.0" x 1.2" (43mm x 76mm x 30mm) Weight: 4oz(113g).
11) Housing: ABS.
12) Service Voltage 48V MCOV 64V.
13) Clamp Voltage 72V Peak.
14) Surge Current 30A/pair.

b. Approved Manufacturers
1) Ditek DTK-MRJPOE.

8. Media Converter
a. Minimum Requirements
1) Ethernet.
2) Data Rate 10/100Base-TX port.
3) Throughput (packet per second) 148,800 pps.
4) Switch Architecture Store-and-forward.
5) Max Packet Size 1522 Bytes.
6) Flow Control Back Pressure for Half Duplex, Mode Pause for Full-Duplex Mode IEEE 802.3x.
7) Connector RJ-45 (Auto-MDI/MDI-X).
8) Electro Static Discharge (ESD) Protection 6KVDC.
9) Cable Type and Distance 10Base-T: 2-pair UTP Cat. 3,4,5, up to 100 m (328 ft.).
10) 100Base-TX: 2-pair UTP Cat. 5e, up to 100 m (328 ft.).
(a) Fiber
11) Data Rate 100Base-FX 802.3u.
12) Connector SFP (Mini-GBIC) port.
13) Fiber Type and Distance Varies by SFP module.
(a) LED Indicators & Controls.
14) Power/Status Green/On – power.
15) Power Fault Proper Operation –Off; Fault Green.
16) 10/100Base-TX port Green/On – active port (TX/RX).
17) SFP (Mini-GBIC) port link Green/On – link established.
18) Reset button Reset to factory default settings.
(a) Electrical & Mechanical.
19) Power (Redundant with reverse polarity pro ect function) 12 ~ 48VDC, .65A (3W Max.).
20) Electrical Fast Transient (EFT) Protection 6KVDC.
21) Alarm Provides one relay output for power failure notification.
22) Alarm relay maximum current: 1A @ 24VDC.
23) Power and Alarm Fault Connector 6-pin removable screw terminal.
24) Enclosure IP30 rated metal enclosure.
25) Dimensions (H x W x D) 5.31 x 1.26 x 3.46 in. (135 x 32 x 88mm).
26) Weight 0.95 lbs. / 430 grams.
27) Environmental
(a) Operating Temperature -40°C ~ +75°C.
(b) Storage Temperature -40°C ~ +85°C.
(c) Relative Humidity 0% ~ 90% (non-condensing) 4)MTBF > 100,000 hrs @ 25°C
28) Mini GBIC
(a) 100Base-FX
(b) Multi Mode
(c) Connector: LC
(d) Operating Temperature -40 to 75 Deg C
29) Approved Products
(a) IFS MC250-1T/1S with Mini-GBIC S25-2MLC-2 and PS12VDC1.5A-U Power Supply.

(b) Or approved equal

9. UPS
   a. Minimum Requirements
      1) Output Power Capacity 2700 Watts / 2880 VA.
      2) Max Configurable Power 2700 Watts / 0 VA.
      3) Nominal Output Voltage 120V.
      4) Topology Line Interactive.
      5) Output Connections (6) NEMA 5-15R NEMA 5-15R (2) NEMA 5-20R.
      6) Include optional Network Monitoring Card.
   b. Approved Products
      1) APC Smart-UPS 3000VA LCD RM 2U 120V US with AP9631 Network Management Card with Environmental Monitoring.
10. Equipment Rack
   a. Minimum Requirements
      1) 19" Equipment Cabinet.
      2) 44 U Height .
      3) 31" Depth .
      4) Fully welded construction, open sides, open back.
      5) UL Listed in the US and Canada.
      6) Fully welded construction provides: ◦ Static load capacity: 10,000 lbs.
      7) UL Listed load capacity: 2,500 lbs.
      8) Laser-cut 1/8" thick internal steel braces for strength.
      9) 14-gauge steel tops & bottoms, 16-gauge seamless steel sides.
      10) Grounding and bonding stud installed in base.
      11) Finished in a durable black textured powder coat.
   b. Approved Products
      1) Middle Atlantic MRK-4431
      2) Or approved equal.
11. Cabling
   a. Refer to cable types shown on the schematic detail.
   b. Provide plenum rated cable unless noted otherwise.
   c. Fiber and CAT6 cabling shall be provided by the Network cabling contractor unless noted otherwise.
   d. Provide all other cables as required for a complete and operational system.
   e. Install per ANSI/TIA 568 and 569.
   f. Provide J Hook cable supports for all cabling.
   g. Where basket tray is provided for low voltage cabling, install cabling in the partition designated for the video system.

PART 3 EXECUTION

3.1 INSTALLATION AND OPERATIONAL REQUIREMENTS FOR THE SECURITY INTEGRATOR

A. Review IP cameras installed by the security contractor prior to connection to the CountyNetwork
   1. Provide IP addressing requirements and confirm correct IP Address has been set for each camera Confirm that the camera is operable and ready for integration During construction, program the camera parameters including;
      a. Resolution – See camera schedule on drawings for resolution settings Bit Rates – Set all cameras to variable bit rate and set an initial max bit rate of 5Mb\s for 1080P cameras and 3MB\s for 720P cameras.
      b. Program the interior cameras to record in time lapse mode at a rate of 1 IPS.
      c. Program the interior cameras to detect motion where persons or vehicles would be seen in the field of View. When motion is detected, program the system to increase the recorded frame rate to 5 IPS.
      d. Estimate the total storage per camera and distributed the cameras evenly across the Network Video Recorders.
      e. Coordinate with the owner to receive a list of titles for all cameras and program all camera titles.
      f. Passwords – Remove all default passwords and configure cameras\recorders with owner provided passwords.

2. Provide patch cables and coordinate patching to the owner provided network switches.

B. Configure owner provided local workstations per Hennepin County Standards. Install Pelco Control Point software and integrate video system with the Andover Continuum Graphics.

C. Camera optimization

1. The Security Integrator shall provide camera optimization 30 days after the building is in normal use.
   a. Record Duration – review the duration of recording and adjust parameters to achieve a minimum of 30 days. If the record duration exceeds 45 days, selectively increase resolution and\or frame rate on select cameras as directed by the owner.
   b. Motion detection – Review the history of the motion detection events per camera and make adjustments to eliminate repetitive false detection including but not limited to:
      1) Low light conditions and AGC noise.
      2) Shadows and light penetration through windows Flicker from light fixtures, signage, equipment LED's, or other light sources Moving objects such as flags, fans, or curtains.
      3) Submit an electronic report of findings to the Engineer and estimate the impact on storage duration once corrections are made. Verify results after 30 days of opera ion.
   c. Bit Rates
      1) Observe bit rates for typical cameras in typical areas:
         (a) Parking areas during peak inrush and also during low light conditions when ramp is empty and lighting is reduced.
         (b) Exterior areas during normal hours and in low light conditions.
         (c) General office during normal hours and in low light conditions.
         (d) Public lobbies during normal hours and in low light conditions.
         (e) Interview rooms during a typical interview and in low light conditions.
      2) Adjust the maximum bit rate to eliminate excessive band idth from poor quality low light images.
      3) Adjust the maximum bandwidth eliminate reduced resolution or frame rate during normal operation.
      4) Demonstrate the recorded video of each interview room camera to the owner for owner approval.
      5) Submit an electronic report of findings to the Engineer and estimate the impact on storage duration once corrections are made. Verify results after 30 days of opera ion.
   d. Storage Load Balancing
      1) If required, reassign cameras to achieve minimum storage dura ions for each Network Video Recorder.

3.2 INSTALLATION AND OPERATIONAL REQUIREMENTS FOR THE SECURITY CONTRACTOR

A. Install cameras, PTZ cameras, Cabling, Media Convertors, Power Supplies, transient protection devices and associated components as shown on plans.

B. Receive a schedule of IP addresses from the Security Integrator and program the IP addresses of each camera.

C. Demonstrate camera operation to the Security Integrator and the owner using a contractor provided laptop PC patched in to the patch panel.

D. Receive signed approval from the owner and the Security Integrator for each camera stating that the field of view, image quality, and location are accepted and ready for handoff to the Security Integrator. Submit written approval to the Engineer.

E. Cameras

1. Prior to the installation of data cabling and electrical rough in, the security contractor shall schedule a coordination meeting where each camera location will be reviewed with:
   a. The General Contractor, Electrical Contractor, Security Integrator, Hennepin County Security, and the Engineer.
   b. During this meeting, the contractor shall provide a laptop PC and typical camera so that the intended view of each camera can be demonstrated and approved. The contractor shall provide all equipment and staff required to support the camera location process.
2. Prior to mounting any cameras in the parking ramp:

a. Submit final camera locations to the General Contractor for approval and for coordination with other trades and receive written approval to proceed.
b. Receive written instructions from the General Contractor describing the restrictions on drilling and fastener types in areas using Post Tension Construction.
c. Submit fastener types and drill depths to the General Contractor and receive written approval to proceed. Provide Hilti type fasteners specifically designed for use in precast structures.

3. Coordination of Exterior PTZ mounts prior to parapet construction, review structural requirements with the General Contractor (See detail drawings)
a. Coordinate with the roofing contractor on the construction of the unistrut frame to ensure correct placement and alignment with the PTZ mounting assembly.
b. Coordinate with the General Contractor to ensure that a fastening point is provided for the PTZ safety cable Mount Video Jboxes on the unistrut frame in a serviceable location.
c. Provide sealtight raceway from the Video Jbox through the rain hood roof penetrations.

F. Video Jboxes Provide a Video Jbox to house media converters and transient protection devices. Coordinate with the electrical contractor for power and grounding.
1. Refer to detail drawings.

G. Network Connections
1. Coordinate with Security Integrator to:
a. Establish network connections to the Security VLAN
b. Define IP address requirements.

H. Cabling
1. Fiber and CAT6 cabling shall be provided by the Network cabling contractor unless noted otherwise.
2. Provide all other cables as required for a complete and operational system.
3. Install per ANSI/TIA 568 and 569.
4. Provide J Hook cable supports for all cabling.
5. Where basket tray is provided for low voltage cabling, install cabling in the partition designated for the video system.

I. Transient Protection
1. Provide Transient Protection devices for all copper conductors entering the facility from exterior locations.

3.3 TRAINING

A. The Security Integrator shall provide a minimum of 3 training sessions. Each session shall last a minimum of two hours.
1. Training shall include:
a. Operator Training – Use of the controls.
b. Building Engineer Training – Review installation, As-Builts, and Maintenance.

3.4 PROJECT CLOSEOUT

A. The Security Integrator shall conduct a final acceptance test with the Owner and Engineer after all system testing is complete and as built documentation has been submitted.
1. Upon completion of the above items and all requirements identified in the plans and specifications:
a. Notify the engineer in writing and request final acceptance.
b. Conduct an on site demonstration to the engineer of system performance and compliance with the plans and specifications.
2. Correct any items noted by the engineer during acceptance and submit a signed punch list of corrections made.
3. The Security Integrator shall conduct the final acceptance test and provide all submittals be ow.
4. Each camera shall be tested in sequential order and a corresponding test report shall be submitted to the engineer.
a. Test each of the following conditions in this order:
1) Titles, numbers, recording parameters are programmed.

2) Cameras are properly focused and cleaned. Fields of view are unobstructed and acceptable to the owner. Submit a report with a signature from the owner that all cameras have been reviewed and are approved.
3) Cables are properly labeled, routed and secured Submit a summary report from the system documenting the recording parameters for each camera.

5. VMS System
   a. Submit system reports documenting
      1) Storage Capacity
      2) Storage Duration
      3) IP Configurations

B. The Security Contractor shall attend the final acceptance test and make repairs as identified bythe Engineer.

END OF SECTION

SECTION 283111
DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire Alarm Control Panel. (Existing)
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Device guards.
7. Firefighters' two-way telephone communication service.
8. Firefighters' smoke-control station.
9. Magnetic door holders.
10. Remote annunciator.
11. Graphic annunciator.
12. Addressable interface device.
13. Network communications.

B. System Spare Capacity

1. Provide spare capacity for fire alarm circuits as required below.
   a. Notification Appliance Circuits (NAC): 25% spare capacity for each circuit installed.
   b. Amplifier Circuits: 25% spare capacity for each circuit installed.
   c. Signaling Line Circuits (SLC): 25% spare capacity for each circuit installed.

C. Related Requirements:

1. Section 087100 “Door Hardware”
2. Section 280500 “Common Work Results for Electronic Safety and Security”
3. Section 230900 “Instrumentation and Controls for HVAC”
4. Section 230993 “Sequence of Operation for HVAC Controls”

1.2 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FACP: Fire Alarm Control Panel.

C. HLI: High Level Interface.

D. NICET: National Institute for Certification in Engineering Technologies.

E. PC: Personal computer.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.

1. Provide coversheet indicating project title, project location, and vendor contact information.
2. Organize submittal into logical sections and provide table of contents.
3. Provide itemized bill of materials indicating model number and quantity for each product.
4. On datasheets with multiple products, indicate which product is provided under this project.
5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
6. Manufacturers' catalog sheets with complete technical data for each item being furnished.

7. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
8. Include plans, elevations, sections, details, and attachments to other work.
9. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
10. Detail assembly and support requirements.
11. Include voltage drop calculations for notification-appliance circuits.
12. Include battery-size calculations.
13. Include input/output matrix.
14. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
15. Include performance parameters and installation details for each detector.
16. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
17. Include performance parameters and installation details for each surge suppression module.
18. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
19. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
20. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:
1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
   a. Trained and certified by manufacturer in fire-alarm system design.
   b. NICET-certified, fire-alarm technician; Level III minimum, Level IV preferred.
   c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017800 "Closeout Submittals," include the following and deliver copies to authorities having jurisdiction:
   a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
   b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.

d. Riser diagram.
e. Device addresses.
f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
g. Record copy of site-specific software.
h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
    1) Equipment tested.
    2) Frequency of testing of installed components.
    3) Frequency of inspection of installed components.
    4) Requirements and recommendations related to results of maintenance.
    5) Manufacturer's user training manuals.
i. Manufacturer's required maintenance related to system warranty requirements.
j. Abbreviated operating instructions for mounting at Fire Alarm Control Panel and each annunciator unit.

B. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
3. Smoke Detectors and Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamper-proofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
8. Surge Protection devices: 2 of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.8 PROJECT CONDITIONS

A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.

B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
1. Notify Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without Owner's written permission.

C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.9 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice/ or horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 EXISTING FIRE-ALARM SYSTEM

A. Compatibility with Existing Equipment: Fire-alarm system and components shall operate as an extension of an existing system.

2.3 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire Alarm Systems Operation Matrix

Initiating Device	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**I**	**J**	**K**	**M**	**N**
Spot type smoke detector	X_1	X_1	X_1	X	–	–	X	–	–	–	–	X
Spot type heat detector	X_1	X_1	X_1	X	–	–	X	–	–	–	–	X
Duct Smoke Detector – Damper	X_2	X_2	X_2	–	X	X	–	–	–	–	–	X
Pre-action heat detector alarm output												
Class “A” Network wire fault	X_3	X_3	X_3	–	–	–	–	–	–	–	–	X
Communication Network Fault	X_3	X_3	X_3	–	–	–	–	–	–	–	–	X
Communication Fault Digital Communicator	X_3	X_3	X_3	–	–	–	–	–	–	–	–	X
Fire Alarm Battery or Charger Failure	X_2	X_2	X_2	–	–	–	–	–	–	–	–	X
User disabling of zones or individual devices	X_2	X_2	X_2	–	–	–	–	–	–	–	–	X
Open circuits, shorts, and grounds in designated circuits.	X_3	X_3	X_3	–	–	–	–	–	–	–	–	X
Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.	X_2	X_2	X_2	–	–	–	–	–	–	–	–	X
Loss of communication with any addressable device	X_3	X_3	X_3	–	–	–	–	–	–	–	–	X
Ground or a single break in internal circuits of fire-alarm control panel	X_2	X_2	X_2	–	–	–	–	–	–	–	–	X
Abnormal ac voltage at fire-alarm control panel	X_2	X_2	X_2	–	–	–	–	–	–	–	–	X
Break in standby battery circuitry	X_2	X_2	X_2	–	–	–	–	–	–	–	–	X
Abnormal position of any switch at fire-alarm control panel or annunciator	X_3	X_3	X_3	–	–	–	–	–	–	–	–	X
Common alarm Signal	X	X	X	X	–	–	–	–	–	–	X	X
Common supervisory signal	X	X	*	–	–	–	–	–	–	–	–	X

Common trouble signal	X	X	*	–	–	–	–	–	–	–	–	X
	A	**B**	**C**	**D**	**E**	**F**	**G**	**I**	**J**	**K**	**M**	**N**

TYPE of SIGNAL
X_1 = Alarm Signal
X_2 = Common supervisory signal
X_3 = Common trouble signal.
– = Action not required.

SYSTEM OPERATION
A = Annunciate specific device at FACP and remote annunciators FAAP.
B = Annunciate specific device at graphic video terminals on Fire Alarm Network
C = Transmit to Central Station/Monitoring.
D = Activate notification appliances as described in specification.
E = Activate relay to close damper.
F = Activate relay to shutdown AHU fan, unless specifically noted otherwise.
G = Activate Exterior Bell/Horn/Strobe.
I = Release all the hold open smoke doors indicated on the drawings.
J = Recall elevator in designated bank.
K = Transmit status to elevator controller
M = Transmit status to access control panel, refer to 281300 for access control system protocol
N = Record events in system memory

MATRIX GENERAL NOTES:

*After a time delay of 200 seconds, transmit trouble or supervisory signal to the remote alarm receiving station.

** Where a paging system is provided shall cease/mute operation during notification appliance activation and reset to normal when the fire alarm system is reset to normal.

2.4 FIRE ALARM CONTROL PANEL (EXISTING)

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Bosch Security Systems, Inc.
   2. EST; a UTC company.
   3. Faraday.
   4. Fike Corporation.
   5. Fire Control Instruments, Inc.: Gamewell; a Honeywell company.
   6. Gamewell-FCI by Honeywell
   7. GE UTC Fire & Security
   8. Harrington Signal, Inc.
   9. Keltron Corporation.
   10. Mircom Technologies, Ltd.
   11. Notifier. Inc, a Honeywell company
   12. Siemens Industry, Inc.; Fire Safety Division.
   13. Silent Knight.
   14. SimplexGrinnell LP.

B. General Requirements for Fire Alarm Control Panel:
   1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
      a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
      b. Include a real-time clock for time annotation of events on the event recorder and printer.
      c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
      d. The FACP shall be listed for connection to a central-station signaling system service.

e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at Fire Alarm Control Panel and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class B.
2. Install no more than 256 addressable devices on each signaling-line circuit.
3. Serial Interfaces:
   a. One dedicated RS 485 port for central-station] operation using point ID DACT.
   b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
   c. One USB port for PC configuration.

E. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at Fire Alarm Control Panel.
2. Activate an approved "alarm-verification" sequence at Fire Alarm Control Panel and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel Fire Alarm Control Panel indication and system reset if the alarm is not verified.

F. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

G. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

J. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provide as a special module that is part of Fire Alarm Control Panel.

1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.

a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
b. Programmable tone and message sequence selection.
c. Standard digitally recorded messages for "Evacuation" and "All Clear."
d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of Fire Alarm Control Panel.

2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

K. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

L. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium.

M. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.5 MANUAL FIRE-ALARM BOXES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. EST; a UTC company.
2. Faraday.
3. Fike Corporation.
4. Fire Control Instruments, Inc.: Gamewell; a Honeywell company.
5. Harrington Signal, Inc.
6. Keltron Corporation.
7. Mircom Technologies, Ltd.
8. Notifier. Inc., a Honeywell company
9. Siemens Industry, Inc.; Fire Safety Division.
10. Silent Knight.
11. SimplexGrinnell LP.
12. System Sensor.

B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to Fire Alarm Control Panel.
2. Station Reset: Key- or wrench-operated switch.

2.6 SYSTEM SMOKE DETECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. EST; a UTC company.
2. FAAST
3. Faraday.
4. Fike Corporation.
5. Fire Control Instruments, Inc.: Gamewell; a Honeywell company.
6. GE UTC Fire & Security; A United Technologies Company.

7. Harrington Signal, Inc.
8. Keltron Corporation.
9. Mircom Technologies, Ltd.
10. Notifier. Inc., a Honeywell company
11. Siemens Industry, Inc.; Fire Safety Division.
12. Silent Knight.
13. SimplexGrinnell LP.
14. System Sensor.
15. Xtralis Pty Ltd.

B. General Requirements for System Smoke Detectors:
1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be two-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to Fire Alarm Control Panel.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at Fire Alarm Control Panel for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by Fire Alarm Control Panel.
   a. Multiple levels of detection sensitivity for each sensor.
   b. Sensitivity levels based on time of day.

C. Photoelectric Smoke Detectors:
1. Detector address shall be accessible from Fire Alarm Control Panel and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at Fire Alarm Control Panel, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

D. Ionization Smoke Detector:
1. Detector address shall be accessible from Fire Alarm Control Panel and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at Fire Alarm Control Panel, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

E. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
1. Detector address shall be accessible from Fire Alarm Control Panel and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at Fire Alarm Control Panel, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.7 HEAT DETECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. EST; a UTC company.
   2. Faraday.
   3. Fike Corporation.
   4. Fire Control Instruments, Inc.: Gamewell; a Honeywell company.
   5. GE UTC Fire & Security; A United Technologies Company.
   6. Harrington Signal, Inc.
   7. Keltron Corporation.
   8. Mircom Technologies, Ltd.
   9. Notifier. Inc., a Honeywell company
   10. Siemens Industry, Inc.; Fire Safety Division.
   11. Silent Knight.
   12. SimplexGrinnell LP.
   13. System Sensor.

B. General Requirements for Heat Detectors: Comply with UL 521.
   1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to Fire Alarm Control Panel.

D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to Fire Alarm Control Panel.

2.8 NOTIFICATION APPLIANCES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper Wheelock.
   2. EST; a division of GE Security.
   3. Federal Signal Corporation.
   4. Fire Control Instruments, Inc.; a Honeywell company.
   5. GAMEWELL.
   6. GE UTC Fire & Security; A United Technologies Company.
   7. Gentex Corporation.
   8. Harrington Signal, Inc.
   9. Keltron Corporation.
   10. Mircom Technologies, Ltd.
   11. Notifier.
   12. Siemens Industry, Inc.; Fire Safety Division.
   13. SimplexGrinnell LP.
   14. System Sensor.

B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.

D. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
   1. Rated Light Output:
      a. 15/30/75/110 cd, selectable in the field.
   2. Mounting: Wall mounted unless otherwise indicated.
   3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
   4. Flashing shall be in a temporal pattern, synchronized with other units.
   5. Strobe Leads: Factory connected to screw terminals.
   6. Mounting Faceplate: Factory finished white.

E. Voice/Tone Notification Appliances:
   1. Comply with UL 1480.
   2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
   3. High-Range Units: Rated 2 to 15 W.
   1. Low-Range Units: Rated 1/8 to 2 W.
   2. Frequency Range: 300Hz to 8000Hz
   3. Mounting: Flush.
   4. Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.9 FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SERVICE

A. Dedicated, two-way, supervised, telephone voice communication links between Fire Alarm Control Panel , and remote firefighters' telephone stations. Supervised telephone lines shall be connected to talk circuits by controls in a control module. Provide the following:
   1. Common-talk type for firefighter use only.
   2. Selective-talk type for use by firefighters and fire wardens.
   3. Controls to disconnect phones from talk circuits if too many phones are in use simultaneously. An indicator lamp shall flash if a phone is disconnected from the talk circuits.
   4. Addressable firefighters' phone modules to monitor and control a loop of firefighter phones. Module shall be capable of differentiating between normal, off-hook, and trouble conditions.
   5. Audible Pulse and Tone Generator, and High-Intensity Lamp: When a remote telephone is taken off the hook, it causes an audible signal to sound and a high-intensity lamp to flash at the Fire Alarm Control Panel.
   6. Selector panel controls to provide for simultaneous operation of up to six telephones in selected zones. Indicate ground faults and open or shorted telephone lines on the panel front by individual LEDs.
   7. Display: Digital to indicate location of caller.
   8. Remote Telephone Cabinet: Flush- or surface-mounted cabinet as indicated, factory-standard red finish, with handset.
      a. Install one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating "Fire Emergency Phone."
      b. With "break-glass" type door access lock.
   9. Remote Telephone Jack Stations: Single-gang, stainless-steel-plate mounted plug, engraved "Fire Emergency Phone."
   10. Handsets: Push-to-talk-type sets with noise-canceling microphone stored in a cabinet adjacent to Fire Alarm Control Panel.

2.10 FIREFIGHTERS' SMOKE-CONTROL SYSTEM

A. Initiate Smoke-Management Sequence of Operation:

1. Comply with sequence of operation as described in Section 230993 "Sequence of Operations for HVAC Controls."
2. Fire-alarm system shall provide all interfaces and control points required to properly activate smoke-management systems.
3. First fire-alarm system initiating device to go into alarm condition shall activate the smoke-control functions.
4. Subsequent devices going into alarm condition shall have no effect on the smoke-control mode.
5. Where smoke hatches are installed shall be fusible link interfaced with smoke control panel.

B. Addressable Relay Modules:
1. Provide address-setting means on the module. Store an internal identifying code for control panel use to identify the module type.
2. Allow the control panel to switch the relay contacts on command.
3. Have a minimum of two normally open and two normally closed contacts available for field wiring.
4. Listed for controlling HVAC fan motor controllers.

2.11 REMOTE DEVICE LOCATION-INDICATING LIGHTS AND IDENTIFICATION PLATES

A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.12 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V ac or dc.
4. Rating: 120-V ac.

B. Material and Finish: Match door hardware.

C. Provide a local switch for hold open release.

2.13 SECONDARY POWER SUPPLIES

A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
1. EST; a UTC company.
2. Honeywell Power Supplies
3. Altronix Power Supplies

B. Standby power supply shall be an electrical battery with capacity to operate the system under maximum supervisory load for 24-hours and capable of operating the system for fifteen 15-minutes of evacuation alarm on all devices, operating at maximum load.

C. The system shall include a charging circuit to automatically maintain the electrical charge of the battery and supervise the integrity of the battery. The system shall automatically adjust the charging rate of the battery to compensate for temperature.

D. All system power supplies shall be capable of recharging their associated batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.

E. Secondary power supplies shall also meet the minimum specifications:
1. The power supply shall meet or exceed the following specifications:
a. The design shall consist of grey or red steel wall-mount housing with a locking door.
b. The power supply shall provide with isolated 24 VAC outputs.

c. The power supply shall provide resettable fuses for each output.

d. PTC protected outputs shall meet Class 2, power limited, requirements.

e. Notification Appliance Circuit (NAC) power extenders shall have the capability to synchronize all strobe and audible signals in accordance with NFPA-72.

f. All power supplies shall be electrically supervised and report a trouble signal for all fault and failure conditions.

2. The electrical specifications for the power supply shall be as follows:

a. Input voltage: 120 VAC

b. Input power: 400 VA

c. Output voltage: 24 VAC

d. Output power: 50 VA

2.14 ADDRESSABLE INTERFACE DEVICE

A. General:
1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall or to circuit-breaker shunt trip for power shutdown.
1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. AHU shutdown relays shall be provided where air handler shutdown is required. The shutdown relay shall be controlled by either a supervised NAC circuit, independently controlled programmable supervised duct detector output circuit, or I/O point circuit. The shutdown relay shall not be controlled by an electronic control module. Each shutdown relay shall have two sets of form C contacts, the first set to be used for the shutdown signal and the second set used for notification to the building automation system.

E. Control Module:
1. Operate notification devices.
2. Operate solenoids for use in sprinkler service.

2.15 NETWORK COMMUNICATIONS

A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.

B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the supervising station.
3. Expand, modify, and supplement existing control equipment as necessary to extend existing [control] [monitoring] functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.

D. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.
4. Install alarm cover where noted.

E. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet (9 m).
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches (910 mm) from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

F. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

G. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

H. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

I. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

J. Audible Alarm-Indicating Devices: Install wall mounted devices not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

K. Ceiling Mounted Audible/Visual and Visual Only Alarm-Indicating Devices: Install flush on ceiling in approximate location indicated. Coordinate with all ceiling mounted diffusers, lights, devices, etc. Provide concealed mounting where noted with UL listed device.

L. Visible Alarm-Indicating Devices: Install wall mounted devices adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.

M. Device Location-Indicating Lights: Locate in public space near the device they monitor.

N. Provide microelectronic monitor modules with 120V relays for each smoke damper connection to provide individual programmed control of damper(s).

O. Provide microelectronic monitor modules for AHU for power shutdown. The shutdown relay shall be located adjacent to the controller for the AHU.

3.3 PATHWAYS

A. Conductors and cables above recessed ceilings and in nonaccessible locations may be routed exposed.
   1. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT.

B. Conductors and cables shall be installed in EMT.

C. Minimum Pathway Size: 3/4-inch (21-mm) trade size. Minimum size for structured cabling is 1 inch (27 mm).

D. Exposed EMT shall be painted red enamel.

3.4 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
   1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
   1. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
   2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
   3. Smoke dampers in air ducts of designated HVAC duct systems.
   4. Magnetically held-open doors.
   5. Electronically locked doors and access gates.
   6. Data communication circuits for connection to building management system.
   7. Data communication circuits for connection to mass notification system.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 GROUNDING

A. Ground Fire Alarm Control Panel and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to Fire Alarm Control Panel.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visual Inspection: Conduct visual inspection prior to testing.
   a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [two] <Insert number> years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION