E.

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 23 73 13.2

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Common electrical installation requirements.
6. Commissioning requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 GENERAL REQUIREMENTS

A. Carefully examine General Conditions, other specification sections, and other drawings (in addition to DIVISION 26), in order to be fully acquainted with their effect on electrical work. Additions to the contract cost will not be allowed due to failure to inspect existing conditions.

B. Do all work in compliance with 2015 Florida Building Code with 2012 supplements, and the Codes adopted therein, including NFPA 70 (2011 NEC), 2014 Florida Fire Prevention Code and the regulations of the local power utility, cable television and telephone companies. Obtain and pay for any and all required permits, inspections, certificates of inspections and approval, and the like, and deliver such certificates to the Architect/Engineer.

C. Cooperate and coordinate with all other trades. Perform work in such manner and at such times as not to delay work of other trades. Complete all work as soon as the condition of the structure and installations of equipment will permit. Patch, in a satisfactory manner and by the proper craft, any work damaged by electrical workmen.

D. Furnish, perform, or otherwise provide all labor (including, but not limited to, all planning, purchasing, transporting, rigging, hoisting, storing, installing, testing, chasing, channeling, cutting, trenching, excavating and backfilling), coordination, field verification, equipment installation, support, and safety, supplies, and materials necessary for the correct installation of complete and functional electrical systems (as described or implied by these specifications and the applicable drawings).

E. Coordinate and verify power and telephone company service requirements prior to bid. Bid to include all work required.

F. Circuiting and connection of all items using electric power shall be included under this division of the specifications, including necessary wire, conduit, circuit protection, disconnects and accessories. Secure rough-in drawings and connection information for equipment involved to determine the exact requirements. See all divisions of drawings or specifications for electrically operated equipment. If the connection of an item is not shown on the electrical drawings and it is unclear how to provide for the circuiting and connection, notify the engineer of record in writing prior to bidding project. Submission of a bid indicates that the bidder has included these requirements as part of the scope of work.

1.5 DRAWINGS:

A. Indicate only diagrammatically the extent, general character, and approximate location of work. Where work is indicated, but with minor details omitted, furnish and install it complete and so as to perform its intended functions.

B. DIVISION 26 work called for under any section of the project specifications, shall be considered as included in this work unless specifically excluded by inclusion in some other branch of the work. This shall include roughing-in for connections and equipment as called for or inferred. Check all drawings and specifications for the project and shall be responsible for the installation of all DIVISION 26 work.

C. Take finish dimensions at the job site in preference to scale dimensions. Do not scale drawings where specific details and dimensions for DIVISION 26 work are not shown on the drawings, take measurements and make layouts as required for the proper installation of the work and coordination with all drawings and coordination with all other work on the project. In case of any discrepancies between the drawings and the specifications that have not been clarified by addendum prior to bidding, it shall be assumed by the signing of the contract that the higher cost (if any difference in costs) is included in the contract price, and perform the work in accordance with the drawings or with the specifications, as determined and approved by the Architect/ Engineer, and no additional costs shall be allowed to the base contract price.

D. Carefully check the drawings and specifications of all trades and divisions before installing any of his work. He shall in all cases consider the work of all other trades, and shall coordinate his work with them so that the best arrangements of all equipment, piping, conduit, ducts, rough-in, etc., can be obtained.

E. Review the specific equipment (such as mechanical, plumbing, kitchen, FFE, etc) minimum circuit ampacity and maximum over current protection requirements of

equipment provided by others to confirm it is properly coordinated with the devices being purchased. Notify the AE team immediately upon discovery of discrepancies. This shall be done at the submittal stage prior to purchasing over current protection or installation of conduit, wire, disconnects, breakers, etc. No cost will be allowed for changes to coordinate.

F. Locations designated for outlets, switches, equipment, etc., are approximate and shall be verified by instruction in these specifications and/or notes on the drawings. Where instructions or notes are insufficient to convey the intent of the design, consult the Architect/Engineer prior to installation.

G. Obtain manufacturer's data on all equipment, the dimensions of which may affect electrical work. Use this data to coordinate proper service characteristics, entry locations, etc., and to ensure minimum clearances are maintained.

H. Provide to owner detailed drawing showing exact dimensions, locations of equipment and room penetrations for all electrical and mechanical rooms before any rough-ins. Drawing shall also include type and location of equipment feeders (top or bottom fed).

1.6 QUALIFICATIONS OF CONTRACTOR:

A. DIVISION 26 Contractor shall have had experience of at least the same size and scope as this project, on at least two other projects within the last five years in order to be qualified to bid this project.

B. Contractor performing any part of this scope of work shall be a State Certified (Type E.C. License) electrical contractor

C. Provide field superintendent who has had a minimum of four (4) years previous successful experience on projects of comparable size and complexity. Superintendent shall be on the site at all times during construction and must have an active Journeyman's Electrical License.

1.7 SITE VISIT/CONDITIONS

A. Visit the site of this contract and thoroughly familiarize with all existing field conditions and the proposed work as described or implied by the contract documents. During the course of his site visit, verify every aspect of the proposed work and the existing field conditions in the areas of construction which might affect his work. No compensation or reimbursement for additional expenses incurred due to failure or neglect to make a thorough investigation of the contract documents and the existing site conditions will be permitted.

B. Install all equipment so that all Code required and Manufacturer recommended servicing clearances are maintained. Coordinate the proper arrangement and installation of all equipment within any designated space. If it is determined that a departure from the Contract Documents is necessary, submit to the A/E, for approval, detailed drawings of the proposed changes with written reasons for the changes. No

changes shall be implemented without the issuance of the required drawings, clarifications, and/or change orders.

C. Submission of a proposal will be construed as evidence that such examination has been made and later claims for labor, equipment or materials required because of difficulties encountered will not be recognized.

D. Existing conditions and utilities indicated are taken from existing construction documents, surveys, and field investigations. Unforeseen conditions probably exist and existing conditions shown on drawings may differ from the actual existing installation with the result being that new work may not be field located exactly as shown on the drawings. Field verify dimensions of all site utilities, conduit routing, boxes, etc., prior to bidding and include any deviations in the contract. Notify A/E if deviations are found.

E. All existing electrical is not shown. Become familiar with all existing conditions prior to bidding, and include in the bid the removal of all electrical equipment, wire, conduit, devices, fixtures, etc. that is not being reused, back to it's originating point.

F. Locate all existing utilities and protect them from damage. Pay for repair or replacement of utilities or other property damaged by operations in conjunction with the completion of this work.

G. Investigate site thoroughly and reroute all conduit and wiring in area of construction in order to maintain continuity of existing circuitry. Existing conduits indicated in Contract Documents indicate approximate locations. Verify and coordinate existing site conduits and pipes prior to any excavation on site. Bids shall include hand digging and all required rerouting in areas of existing conduits or pipes.

H. Work is in connection with existing buildings which must remain in operation while work is being performed. Work shall be in accord with the schedule required by the Contract. Schedule work for a minimum outage to Owner. Notify Owner 72 hours in advance of any shut-down of existing systems. Perform work during non-school operating hours unless otherwise accepted by Owner. Protect existing buildings and equipment during construction.

1.8 COMMISSIONING RESPONSIBILITIES

A. Attend commissioning meetings scheduled by the CM.

B. Schedule work so that required electrical installations are completed, and system verification checks and functional performance test can be carried out on schedule.

C. Inspect, check and confirm in writing the proper installation and performance of all electrical services as required by the system verification and functional performance testing requirements of electrical equipment in the commissioning specifications.

D. Provide qualified personnel to assist and operate electrical system during system verification checks and functional performance testing of HVAC systems as required by the commissioning specifications.

E. Provide instruction and demonstrations for the Owner's designated operating staff in accordance with the requirements of the commissioning specifications.

1.9 TEMPORARY POWER:

A. Provide temporary power distribution for the connection of all single phase 120V 20A tools, OSHA work lighting, and testing as required for performance of the project. Provide OSHA required work lighting and task lighting for the project.

B. Coordinate requirements with the local Utility Company for availability of adequate power. Include all cost associated with any Utility Company charges for connection or upgrades in this bid price.

C. If power to any of the existing facilities will be interrupted, coordinate the outage with the Owner atleast 72 hours in advance. All power outages will occur outside operational hours as determined by the Owner.

D. Provide temporary power to any buildings, parking lot lighting, canopy lighting, lift stations, etc that will have power removed during the course of construction temporarily. Additionally, if any new buildings, parking lots, lift stations, etc will need power until the permanent power becomes available, provide temporary power until the permanent power is available.

E. Provide temporary lighting for all areas that will require lighting for school use as well as construction use during the course of construction. Temporary lighting must comply with all FBC requirements as though it was being installed for permanent use. This includes but is not limited to any temporary canopies, parking lots, walkways or roads. If you are unsure of how to connect or provide this lighting, notify the engineer of record in writing prior to bidding project. Submission of a bid indicates that the bidder has included these requirements as part of the scope of work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Engineer shall have no responsibility for job site safety and the Contractor shall have full and sole authority for all safety programs and precautions in connection with the Work. Nothing herein shall be interpreted to confer upon the Engineer any duty regarding safety or the prevention of accidents at the jobsite.

B. Comply with NECA 1.

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

D. 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.

E. 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.

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

G. Coordinate work with all other trades before any rough-ins. Contractor to provide EOR and user a proposed layout of equipment inside of mechanical and electrical places prior to any installation to make sure that all clearances are met.

H. All work shall be executed in a workmanship manner and shall present a neat mechanical appearance upon completion.

I. Care shall be exercised that all items are plumb, straight, level.

J. Care shall be exercised so that Code clearance is allowed for all panels, controls. etc., requiring it. Do not allow other trades to infringe on this clearance.

K. Balance load as equally as practicable on all feeders, circuits and panel buses.

L. The electrical circuits, components and controls for all equipment are selected and sized based on the equipment specified. If substitutions are proposed, furnish all materials and data required to prove equivalence. No additional charges shall be allowed if additional materials, labor, connections or equipment are needed for substituted products.

M. All exterior enclosures to be NEMA 4X stainless steel.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Coordinate with roofing scope of work for the installation of electrical items which pierce roof. Roof penetrations shall not void warranty. Pitch pockets are not acceptable. Coordinate directly with approved roofing vendor prior to any rough-in.

D. Where work pierces waterproofing, it shall maintain the integrity of the waterproofing. Coordinate roofing materials which pierce roof for compatibility with membrane or other roof types.

E. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

F. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

G. Cut sleeves to length for mounting flush with both surfaces of walls.

H. Extend sleeves installed in floors 2 inches above finished floor level.

I. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

J. Seal space outside of sleeves with grout for penetrations of concrete and masonry

K. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants.".

L. Fire-Rated-Assembly Penetrations: Firestop penetrations of walls, partitions, ceilings, and floors under Division 07 Section "Firestopping."

M. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work. The use of pitch pockets is not acceptable.

3.3 CONCRETE PADS

A. Furnish and install reinforced concrete housekeeping pads for all free-standing equipment. Unless otherwise noted, pads shall be four (4) inches high and shall exceed dimensions of equipment being set on them, including future sections, and 3000psi concrete with no greater than a (2) inch lip around the equipment, except when equipment is flush against a wall where the side against the wall shall be flush with the equipment.

B. Provide concrete pad for exterior generators and manual transfer switch as recommended by generator manufacturer and structural engineer (8" minimum).

3.4 MISCELLANEOUS CIRCUITS REQUIRED

A. Provide 120 volt, 20 amp circuit to fire protection system panel and bell (whether shown on drawings or not). Connect to spare 20 amp, 1 pole circuit breaker in nearest 120 volt panel. Notify Engineer of Record of required circuit so that final circuit information may be provided to the contractor. Re-label circuit breaker accordingly. Provide locking device on breaker. Coordinate location with civil engineer (and drawings/specifications) or fire protection engineer (and drawings/specifications) prior to bid and provide all electrical. Coordinate final location and electrical requirements

with panel installer after bid and provide all electrical. Nearest panel to be nearest emergency panel, when building has emergency generator system.

B. Provide 120 volt, 20 amp circuit to all fire alarm panels, remote panels, etc (whether shown on drawings or not). Connect to spare 20 amp, 1 pole circuit breaker in nearest 120 volt panel. Notify Engineer of Record of required circuit so that final circuit information may be added to the drawings. Re-label circuit breaker accordingly. Provide locking device on breaker. Coordinate location with fire alarm system engineer (and drawings/specifications) prior to bid and provide all electrical. Coordinate final location and electrical requirements with panel installer after bid and provide all electrical. Nearest panel to be nearest emergency panel, when building has emergency generator system.

C. Provide 120 volt, 20 amp circuit to fire and smoke dampers (whether shown on drawings or not). Connect to spare 20 amp, 1 pole circuit breaker in nearest 120 volt panel. Notify Engineer (whether shown on drawings or not) Provide locking device on breaker. Coordinate location with fire protection engineer (and drawings/specifications) prior to bid and provide all electrical. Coordinate final location and electrical requirements with damper installer after bid and provide all electrical. Nearest panel to be nearest emergency panel, when building has emergency generator system.

D. Provide 120 volt, 20 amp circuit to building control panels for HVAC system (whether shown on drawings or not). Connect to spare 20 amp, 1 pole circuit breaker in nearest 120 volt panel. Notify Engineer of Record of required circuit so that final circuit information may be added to the drawings. Re-label circuit breaker accordingly. Coordinate location with drawings or specifications prior to bid and provide all electrical.

END OF SECTION 260500

SECTION 26 05 01
INVESTIGATION OF EXISTING ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual conditions and Division 1 Specification sections apply to this section.

1.2 SUMMARY

A. This section includes the requirements for investigation and reporting on conditions of existing electrical systems.

1.3 DESCRIPTION

A. Test the essential features of existing electrical grounding systems.

B. System shall be tested once only, and after completion of testing, results given to the Owner. Point out any non-operational function noticed during testing.

C. Document the existing conditions and operation of the existing electrical systems prior to any work.

D. Contractor shall be responsible for all non-working systems and their components unless non-working status is verified prior to work on system.

1.4 COORDINATION

A. The testing shall be held at a date to be agreed upon in writing by the Owner.

PART 2 - PRODUCTS (not applicable)

PART 3 - EXECUTION

3.1 PERFORMANCE VERIFICATION

A. The contractor shall investigate all existing systems prior to the beginning any work on site. Test the functionality of each system and report only those items that are non-functional to the Owner.

B. Demonstrate to the Owner the non-functional items to verify the issue. Owner will at its option correct the deficiency immediately or defer to correct until the construction is completed. Provide a written report to clarify the items and the Owners decisions on correction,

C. Each system shall be retested after completion of renovation to ensure proper operation.

D. At the completion of construction, the Owner will expect all power, lighting and systems to function for their intended purpose whether new or existing. The contractor will remain responsible for this unless noted otherwise during the initial investigation and documented and demonstrated as such.

3.2 MEMO OF INVESTIGATION (TESTING)

A. Submit Existing Facilities Investigation Memo and advise Owner of all deficiencies in system(s) prior to Work. All systems will be assumed to be fully operational if Memo is not received by Owner prior to work on system.

END OF SECTION 260501

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.
   3. Sleeves and sleeve seals for cables.
   4. Metal Clad cable, Type MC

B. Related Sections include the following:
   1. Division 27 Section "Data Communications Integration" for cabling used for voice and data circuits.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Provide type and UL listing of each type of conductor, cable, connector and termination to be utilized for the DIVISION 26 scope of work.

B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled as defined in NFPA 70, Article 100.

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of cables with other installations.

B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Architect.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Alcan Products Corporation; Alcan Cable Division.
   2. American Insulated Wire Corp.; a Leviton Company.
   3. General Cable Corporation.
   4. Senator Wire & Cable Company.
   5. Southwire Company.

B. BUILDING WIRES AND CABLES
   1. CONDUCTOR INSULATION
      a. Comply with NEMA WC 70 for Types THHN-THWN
      b. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN CU, single conductors in raceway.
      c. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN CU, single conductors in raceway.
      d. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN CU, single conductors in raceway.
      e. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN CU, single conductors in raceway.
      f. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN CU, single conductors in raceway. Minimum #12.
      g. Class 1 Control Circuits: Type THHN-THWN CU, in raceway.
      h. Class 2 Control Circuits: Type THHN-THWN CU, in raceway.
   2. Conductor Material:
      a. Copper Conductors: Comply with NEMA WC 70.
      b. All conductors shall be stranded CU conductors.
   3. Conductors and cables shall be provided with factory colored insulation.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. AMP Incorporated
   3. Anderson

4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M; Electrical Products Division.
6. Burndy

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

C. Provide sleeves using hydrolic Hy-Press methods for splices made in conductors #4 AWG and larger.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONDUCTORS AND CABLES IN RACEWAY

A. No cables shall be installed in raceways until the raceway system is complete from end to end.

B. Examine raceways and building finishes to confirm compliance with contract requirements for installation tolerances and other conditions affecting installation of wires and cables. Do not proceed with installation until area is ready and any unsatisfactory conditions have been corrected.

C. Verify that interior of building has been protected from weather.

D. 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.

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

F. All branch circuit wire shall be sized for a maximum voltage drop of 3%. The contractor shall size all cables to comply with this requirement. Below are some guidelines that may be followed to achieve the correct voltage drop in lieu of providing custom calculations for each case.
1. Use conductor not smaller than #12 AWG for all 120V 20A branch circuits less than 60’ in length from the source breaker to any device.
2. All 120V branch circuit conductors where the length is 61’ to 120’ from the source breaker to any device shall utilize #10 minimum throughout the circuit, unless otherwise noted.
3. All 120V branch circuit conductors where the length is 121’ to 240’ from the source breaker to any device shall utilize # 8 minimum throughout the circuit, unless otherwise noted.
4. All 120V branch circuit conductors where the length is greater than 241’ from the source breaker to any device shall utilize # 6 minimum throughout the circuit, unless otherwise noted.
5. Use conductor not smaller than #12 AWG for all 277V 20A branch circuits less than 140’ in length from the source breaker to any device.

6. All 277V branch circuit conductors where the length is 141’ to 220’ from the source breaker to any device shall utilize #10 minimum throughout the circuit, unless otherwise noted.
7. All 277V branch circuit conductors where the length is 221’ to 340’ from the source breaker to any device shall utilize # 8 minimum throughout the circuit, unless otherwise noted.
8. All 277V 20A branch circuit conductors where the length is greater than 341’ from the source breaker to any device shall utilize # 6 minimum throughout the circuit, unless otherwise noted.

G. Provide a dedicated neutral conductor for all branch circuits and feeders.

H. Neatly train and lace wiring inside boxes, equipment, and panelboards. Secure with cable ties; no tape allowed.

I. Conductor sizes indicated on circuit homeruns or in schedules shall be installed over the entire length of the circuit unless noted otherwise on the drawings or in these specifications.

J. Before installing raceways and pulling wire to any mechanical equipment, verify electrical characteristics with final submittal on equipment to assure proper number and AWG of conductors. (As for multiple speed motors, different motor starter arrangements, etc.).

Coordinate all wire sizes with lug sizes on equipment, devices, etc. Provide/install lugs as required to match wire size.

3.2 CONNECTIONS

A. Where oversized conductors are called for (due to voltage drop, etc.) provide/install lugs as required to match conductors, or provide/install splice box, and splice to reduce conductor size to match lug size.

B. 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 and UL 486B.

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

D. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

E. Power and lighting conductors shall be continuous and unspliced where located within conduit. Splices shall occur within troughs, wireways, outlet boxes, or equipment enclosures where sufficient additional room is provided for all splices. No splices shall be made in in-ground pull boxes (without written acceptance of engineer).

F. Splices in lighting and power outlet boxes, wireway, and troughs shall be kept to a minimum, pull conductors through to equipment, terminal cabinets, and devices.

G. No splices shall be made in junction box, and outlet boxes (wire No. 8 and larger) without written acceptance of Engineer.

H. 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 and UL 486B. A calibrated torque wrench shall be used for all bolt tightening.

I. All interior power and lighting taps and splices in No. 8 or smaller shall be fastened together by means of "spring type" connectors. All taps and splices in wire larger than No. 8 shall be made with compression type connectors and taped to provide insulation equal to wire. Utilize weatherproof connectors for all splices in exterior boxes. Tapes on insulated splices are not allowed.

J. No splices are permitted in exterior below grade handhole or pull boxes.

3.3 FIELD QUALITY CONTROL

A. After feeders are in place, but before being connected to devices and equipment, test for shorts, opens, and for intentional and unintentional grounds.

B. Cables 600 volts or less in size #1/0 and larger shall be meggered using an industry approved “megger” with 1000 V internal generating voltage. Readings shall be recorded and submitted to the Engineer for acceptance prior to energizing same. If values are less than recommended NETA values notify Engineer. Submit five copies of tabulated megger test values for all cables.

C. Cables 250 volts or less in size #1/0 and larger shall be meggered using an industry approved “megger” with 500 V internal generating voltage. Readings shall be recorded and submitted to the Engineer, for acceptance prior to energizing same. Submit five copies of tabulated megger test values for all cables.

D. Perform Insulation resistance test and turns ratio test. Submit five copies to engineer at substantial completion.

E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems, equipment and common ground bonding with lightning protection system.

1.3 SUBMITTALS

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

B. Field quality-control test reports.

1.4 QUALITY ASSURANCE

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

B. Test all ground rod locations as described to confirm quality standard intent is attained.

PART 2 - PRODUCTS

2.1 CONDUCTORS

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

B. 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 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 wide and 1/16 inch thick.

C. Grounding Bus: Rectangular bars of annealed copper, min ¼" x 4" x 12" with 3/8" and 1" hole, 1-3/4" spacing vertically and 1" spacing horizontally.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory 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, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Lugs: Compression of substantial construction, cast copper or cast bronze, with "ground" (micro-flat) surfaces, twin clamp, two-hole tongue, equal to Burndy or equal by T&B or OZ Gedney. Lightweight and "competitive" devices shall be rejected.

E. Grounding and Bonding Bushings: Malleable iron, Thomas and Betts (T&B), or equal.

F. Grounding Screw and Pigtail: Stranded.

G. Building Structural Steel, Existing: Thompson 701 Series heavy duty bronze "C" clamp with two-bolt vise-grip cable clamp or equal.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 5/8 inch by 10 feet in diameter.

2.4 GROUNDING WELL COMPONENTS

A. All Areas:

1. Well: Minimum 12 inch long by 12 inch wide by 18 inches deep with open bottom.
2. Well Cover: Traffic rated for use with "GROUND" embossed on cover.
3. Material: Composolite.
4. Manufacturer: Quazite.
5. Increase depth, diameter or size as required to provide proper access at installed location.

2.5 GROUNDING BARS/GROUND BUS (INCLUDING 'SYSTEMS' GROUND BUS/BARS AND GROUND BUS BARS)

A. Ground bars shall be copper of the size and description as shown on the drawings. If not sized on drawings, bus bar shall be minimum 1/4" x 4" bus grade copper, spaced from wall on insulating 2" polyester molded insulator standoff/supports, and be 12" overall length, allowing 2" length per lug connected thereto. Increase overall length as required to facilitate all lugs required while maintaining 2" spacing. Size of bus bar used in main electrical room shall be similar except minimum of 4" high and 24" long. Provide bus with 25% spare space available.

B. Provide bolt-tapping lug with two hex head mounting bolts for each terminating ground conductor, sized to match conductors. Mount on bus bar at 2 inches on center spacing. Lugs to be manufactured by Burndy or T&B. ¾” and 1” stainless steel bolt, LW and HN.

C. Standoff supports to be 2" polyester as manufactured by Glastic #2015-4C.

PART 3 - EXECUTION

3.1 GROUNDING ELECTRODES

A. All connections shall be exothermic welded unless otherwise noted herein. All connections above grade and in accessible locations may be by exothermic welding or by braising or clamping with devices UL listed as suitable for use except in locations where exothermic welding is specifically specified in these specifications or called for on drawings.

B. Each rod shall be die stamped with identification of manufacturer and rod length.

C. Install rod electrodes at locations indicated and/or as called for in these specifications.

D. Ground Resistance:

1. Main Electrical Service (to each building) and Generator Locations:

    a. Grounding resistance measured at each main service electrode system and at each generator electrode system shall not exceed 5 ohms.

2. Other Locations:

    a. Resistance to ground of all non-current carrying metal parts shall not exceed 5 ohms measured at motors, panels, busses, cabinets, equipment racks, light poles, transformers, and other equipment.

3. Lightning Protection system ground locations shall not exceed 5 ohms for the Franklin system measured at ground electrode.
4. Resistance called for above shall be maximum resistance of each ground electrode prior to connection to grounding electrode conductor. Where ground electrode system being measured consists of two (2) or more ground rod

electrodes then the resistance specified above shall be the maximum resistance with two (2) or more rods connected together but not connected to the grounding electrode conductor.

E. Install additional rod electrodes as required to achieve specified resistance to ground (specified ground resistance is for each ground rod location prior to connection to ground electrode conductor). Depending on soil condition, etc. of ground rod locations it has been found that the ground rod lengths required to achieve the specified resistance may range from the minimum specified length to up to 80 feet or more in length.

F. Verify that final backfill and compaction has been completed before driving rod electrodes.

G. Install ground rods not less than 1 foot below grade level and not less than 2 feet from structure foundation.

3.2 EQUIPMENT GROUNDING CONDUCTOR

A. Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

B. Provide green insulated ground wire for all grounding type receptacles and for equipment of all voltages. In addition to grounding strap connection to metallic outlet boxes, a supplemental grounding wire and screw equal to Raco No. 983 shall be provided to connect receptacle ground terminal to the box.

C. All plugstrips and metallic surface raceway shall contain a green insulation ground conductor from supply panel ground bus connected to grounding screw on each receptacle in strip and to strip channel. Conductor shall be continuous.

D. All motors, all heating coil assemblies, and all building equipment requiring flexible connections shall have a green grounding conductor properly connected to the frames and extending continuously inside conduit with circuit conductors to the supply source bus with accepted connectors regardless of conduit size or type. This shall include Food Service equipment, Laundry equipment, and all other "Equipment By Owner" to which an electric conduit is provided under this Division.

3.3 MAIN ELECTRICAL FEEDER

A. Existing Buildings:

1. Verify that each building's electrical service is properly grounded as required by the NEC.
2. Provide and install electrical service grounding at each building as called for herein for all existing services that do not comply with the grounding specified above.
3. Supplement existing electrical service grounding at each building as required to comply with all requirements in these specifications.

4. If exterior ground rod electrode does not exist at each buildings main electrical service, provide and install these ground rods as called for main electrical service, exterior of building. Connect all counterpoise conductors required elsewhere thereto.

B. Ground electrodes shall be provided for the main feeder in sufficient number and configuration to secure resistance specified.

C. Bond to all of the following when available on site:

1. Ground Rods
2. Metal Water Pipe (Interior and Exterior to Building)
3. Building Metal Frame, Structural Steel and/or Reinforced Structural Concrete
4. All Piping Entering or Leaving All Buildings (Including Chilled Water Piping)
5. Encasing Electrodes
6. Ground Ring
7. Site Distribution Counterpoise Ground System
8. Lightning Protection System

D. A main ground, bare copper conductor, sized per applicable table in NEC, but in no case less than #2/0, shall be run in rigid metallic conduit from the main distributionpanel and be bonded to the main water service ahead of any union in pipe and must be metal pipe of length as acceptable by authorities having jurisdiction. Provide properly sized bonding shunt around water meter and/or dielectric unions in the water pipe. Also required is the same size ground wire to ground rod electrode as called for below:

1. Three 30 ft. ground rods in a delta configuration at no less than 30 ft. spacing driven to a minimum depth of 30 ft. plus 1 below grade.
2. Bond ground rod electrodes together with a bare copper ground conductor that matches size required by applicable table in NEC 250, but in no case less than #2/0.
3. Provide additional rod electrodes as required to achieve specified ground resistance.

E. Ground/bond neutral per NEC.

F. Bond grounding electrodes to site counterpoise grounding system and lightning protection system where provided.

G. Provide and install ground bus bar on wall near main service disconnect/switchboard. Connect to ground bar in disconnect/switchboard bonded to switchboard/disconnect enclosure/neutral with copper grounding conductor sized per applicable table in NEC.

3.4 TRANSFORMER GROUNDING

A. Ground all transformers and enclosures of 120/208V and 277/480V "separately derived systems" as specified herein.

1. Ground per NEC 250 and these specifications.

2. Bond neutral to transformer frame/enclosure and the equipment grounding conductors of the derived system with copper ground conductor sized per applicable table in NEC.
3. Connect transformer neutral/ground to grounding electrode per NEC with grounding electrode conductor sized per applicable table in NEC.
4. In addition to connection to grounding electrode conductor called for above (i.e. per NEC) provide, install and connect supplemental grounding electrode as follows:

    a. Where grounding required per NEC is to building steel/structure, supplement this grounding with connection to nearest available effectively grounded metal water pipe.
    b. Where grounding connection required per NEC is to grounded metal water pipe, supplement this grounding with connection to other electrodes specified in NEC.
    c. Where supplemental grounding electrodes required above is a ground rod electrode, provide, install and connect two or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 below grade.

5. Where neither building steel nor water pipe grounding electrodes are available (i.e. exterior locations with no available water pipe electrode) provide two (2) ground connections: each to two (2) or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 below grade.
6. Where transformer is mounted exterior to building one (1) of the two (2) ground electrodes required shall be ground rod electrode as called for in 5. above. This ground rod electrode shall also be connected to counterpoise system (wherever counterpoise system is available).
7. Ground to water system service pipe as required by NEC.

B. Provide additional ground electrodes as required to achieve specified ground resistance.

C. Where two or more ground electrodes are used at any one required ground location, they shall be bonded together with a copper ground conductor, sized to meet applicable table in NEC, but in no case less than #2/0.

D. Provide and install ground bus bar on wall near transformer (or in associated electrical room for exterior mounted transformers). Connect to ground lug in transformer bonded to transformer enclosure/neutral with copper ground conductor sized per applicable table in NEC.

3.5 GENERATOR GROUNDING

A. Separately derived systems (i.e. systems where generator neutral is not solidly interconnected to service supplied system neutral such as 4 pole switched neutral transfer switch systems).

1. Ground per NEC and these specifications.

2. Bond neutral to transformer frame/enclosure and the equipment grounding conductors of the derived system with copper ground conductor sized per applicable table in NEC.
3. Connect generator neutral/ground to grounding electrodes per NEC with grounding electrode conductor sized per applicable table in NEC.
4. In addition to connection to grounding electrode conductor called for above (i.e. per NEC) provide, install and connect supplemental grounding electrode as follows:

    a. Where grounding required per NEC is to building steel/structure, supplement this grounding with connection to nearest available effectively grounded metal water pipe.
    b. Where grounding connection required per NEC is to grounded metal water pipe, supplement this grounding with connection with connection to other electrodes specified in NEC.
    c. Where supplemental grounding electrodes required above is a ground rod electrode, provide, install and connect two or mote 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 below grade.

5. Where neither building steel nor water pipe grounding electrodes are available (i.e. exterior locations with no available water pipe electrode) provide two (2) ground connections: each to two (2) or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 below grade.
6. Where generator is mounted exterior to building one (1) of the two (2) ground electrodes required shall be ground rod electrode as called for in 5. above. This ground rod electrode shall also be connected to counterpoise system.

B. Non separately derived systems (i.e. systems where generator neutral is solidly interconnected to service supplied system neutral such as 3 pole non-switched neutral transfer switch systems).

1. Do not bond neutral to transformer frame/enclosure or the equipment grounding conductors of the derived system.
2. Connect generator frame/enclosures ground to grounding electrode per NEC with grounding electrode conductor sized per applicable table in NEC .
3. In addition to connection to grounding electrode conductor called for above (i.e. per NEC) provide, install and connect supplemental grounding electrode as follows:

    a. Where grounding required per NEC is to building steel/structure, supplement this grounding with connection to nearest available effectively grounded metal water pipe.
    b. Where grounding connection required per NEC is to grounded metal water pipe, supplement this grounding with connection to other electrodes specified in NEC.
    c. Where supplemental grounding electrodes required above is a ground rod electrode, provide, install and connect two or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 below grade.

4. Where neither building steel nor water pipe grounding electrodes are available (i.e. exterior locations with no available water pipe electrode) provide two (2) ground connections: each to two (2) or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 below grade.
5. Where generator is mounted exterior to building one (1) of the two (2) ground electrodes required shall be ground rod electrode as called for in 5. above. This ground rod electrode shall also be connected to counterpoise system.

C. Provide additional ground electrodes as required to achieve specified ground resistance.

D. Where two or more ground electrodes are used at any one required ground location, they shall be bonded together with a copper ground conductor, sized to meet applicable table in NEC, but in no case less than #2/0.

3.6 LIGHTNING PROTECTION SYSTEMS

A. Ground per applicable section on lightning protection system, NFPA 780, and as specified herein. The most stringent requirements shall govern.

B. Bond lightning protection system grounds to electrical service system ground, all piping entering or leaving all buildings, and counterpoise system ground where provided.

C. Lightning protection ground rods shall be 20’ in length and should not be driven deeper. If additional rods are required to achieve the required resistance to ground, they should be added in parallel with the first at one rod length separation.

3.7 EXTERIOR GRADE (OR FREE STANDING ABOVE GROUND) MOUNTED EQUIPMENT

A. General:

1. All equipment (including chillers, pumps, disconnects, starters, control panels, panels, etc) mounted exterior to building shall have their enclosures grounded directly to a grounding electrode at the equipment location in addition to the building equipment ground connection.
2. Bond each equipment enclosure, metal rack support, mounting channels, etc. to ground electrode system at each rack with an insulated copper ground conductor sized to match the grounding electrode conductor required by applicable table in NEC based on equipment feeder size, but in no case shall conductor be smaller than #6 copper or larger than #2 copper. This connection is in addition to grounding electrode connections required for services.

B. Main electrical service rack mounted equipment.

1. Ground per "MAIN ELECTRICAL SERVICE".
2. Bond all metal parts as noted above.

C. Electrical sub service rack mounted equipment.

1. Ground per "MAIN ELECTRICAL SERVICE", except do not bond neutral to ground.
2. Bond all metal parts as noted above.

D. Electrical equipment connection rack mounted equipment.

1. Bond all metal parts as noted above.

E. Grounding electrodes (ground electrodes system) shall be:

1. Located at each rack location.
2. For service equipment: Ground electrode required per "MAIN ELECTRICAL SERVICE".
3. For equipment connection equipment: Two or more 30 ft. ground rods at no less than 30 ft. spacing, driven vertical to a minimum depth of 1 ft below grade. Bond the two or more ground rods together with a size to meet applicable table in NEC , but no less than a #2 copper ground conductor. Provide additional rod electrodes as required to achieve specified ground resistance.

3.8 LIGHTING FIXTURES

A. All new and removed/reinstalled fixtures in building interior, and exterior fixtures shall be provided with green grounding conductor, solidly connected to unit. Individual fixture grounds shall be with lug to fixture body, generally located at point of electrical connection to the fixture unit.

B. All suspended fixtures and those supplied through flexible metallic conduit shall have green ground conductor from outlet box to fixture. Cord connected fixtures shall contain a separate green ground conductor.

C. Pole Light Fixtures:

1. Metal Pole Light Fixtures:

a. Freestanding pole mounted lighting fixtures shall each have a Class I or Class II lightning protection main copper down conductor connected to grounding electrodes at base of pole.
b. Conductor shall be bonded to metal pole via UL Listed ground clamp suitable for use. Locate ground lug opposite to handhole (or adjacent if visible through handhole).

2. Concrete or Non-Metallic Pole:

a. Freestanding pole mounted lighting fixtures shall each have a Class I or Class II lightning protection main copper down conductor connected to grounding electrodes at base of pole.

b. Conductor shall be extended from grounding electrode to top of pole and terminate at the top of pole in a Class I or Class II copper lightning protection air terminal.
c. Each metal part of light fixture assembly, bracket, ballast cabinet, disconnect, transformer, etc. that is mounted to pole shall be bonded to down conductor.

3. Fixtures located on elevated roadway ramps shall be specially provided with a connection to lightning counterpoise grounding system, properly installed.
4. Grounding electrode(s) at each pole shall be connected (bonded) to site distribution counterpoise system.
5. Grounding Electrodes:

a. Two or more 10 ft. ground rods at no less than 10 ft. spacing shall be driven vertically to a minimum depth of 10 ft. plus 1 below grade.
b. Bond the two or more ground rod electrodes together with a Class I or Class II lightning protection main copper conductor.
c. Provide additional rod electrodes as required to achieve specified ground resistance.
d. The two (2) or more grounding rod electrodes shall be installed at each light pole.

6. Installation shall exceed minimum requirements of NFPA 780.

3.9 PULLBOX, MANHOLE, HANDHOLE GROUNDING.

A. One 30 ft. ground rod electrode shall be driven vertically to a minimum depth of 30 ft. plus 1 ft. below grade in each manhole, handhole or pullbox (in ground).

B. Bond to counterpoise system (whenever counterpoise system is provided.)

C. Bond grounding electrode to all exposed metal parts of manhole, handhole, and pullbox (including metal cover) with #6 copper ground conductor. Connect to ground rod electrode with exothermic weld. Connect to metal cover with exothermic weld. Connect to other metal parts with exothermic weld or UL accepted grounding clamp. Provide 3 ft. or more slack ground cable on cover connection as required to facilitate removal of cover.

3.10 GROUND RING

A. Provide complete underground building perimeter ground ring system, completely encircling each building.

B. Conductor shall be minimum of Class II lightning protection copper conductor (bare).

C. Install at not less than 2-1/2 feet depth into earth.

D. Install ground rods 20 ft. long every 150 feet section of ground ring conductor.

E. Bond ground ring to building steel every 150 feet of building perimeter, bond to any and all electrical and piping systems that cross the ground ring system, bond to lightning protection down conductors and to any lightning or other earth grounding electrodes that may be present on the premises.

F. Bond to building service and counterpoise ground systems.

3.11 MISCELLANEOUS GROUNDING CONNECTIONS

A. Provide bonding to meet regulatory requirements.

B. Required connections to building steel shall be with UL accepted non-reversible crimp type ground lugs exothermically welded to bus bar that is either exothermically welded to steel or bolted to steel in locations where weld will not affect the structural properties of the steel. Required connections to existing building structural steel purlins/I beams shall be with heavy duty bronze "C" clamp with two bolt vise-grip cable clamp.

C. Grounding conductors shall: be so installed as to permit shortest and most direct path from equipment to ground; be installed in conduit; be bonded to conduit at both ends when conduit is metal; have connections accessible for inspection; and made with accepted solderless connectors brazed (or bolted) to the equipment or to be grounded; in NO case be a current carrying conductor; have a green jacket unless it is bare copper; be run in conduit with power and branch circuit conductors. The main grounding electrode conductor shall be exothermically welded to ground rods, water pipe, and building steel.

D. All surfaces to which grounding connections are made shall be thoroughly cleaned to maximum conductive condition immediately before connections are made thereto. Metal rustproofing shall be removed at grounding contact surfaces, for 0 ohms by digital Vm. Exposed bare metal at the termination point shall be painted.

E. All ground connections that are buried or in otherwise inaccessible locations, shall be welded exothermically. The weld shall provide a connection which shall not corrode or loosen and which shall be equal or larger in size than the conductors joined together. The connection shall have the same current carrying capacity as the largest conductor.

F. Install ground bushings on all metal conduits entering enclosures where the continuity of grounding is broken between the conduit and enclosure (i.e. metal conduit stub-up into a motor control center enclosure or at ground bus bar). Provide an appropriately sized bond jumper from the ground bushing to the respective equipment ground bus or ground bus bar.

G. Install ground bushings on all metal conduits where the continuity of grounding is broken between the conduit and the electrical distribution system (i.e. metal conduit stub-up from wall outlet box to ceiling space. Provide an appropriately sized bond jumper from the ground bushing to the respective equipment ground bus or ground bus bar.

H. Each feeder metallic conduit shall be bonded at all discontinuities, including at switchboards and all subdistribution and branch circuit panels with conductors in

accordance with applicable table in NEC 250 for parallel return with respective interior grounding conductor.

I. Grounding provisions shall include double locknuts on all heavywall conduits.

J. Bond all metal parts of pole light fixtures to ground rod at base.

K. Install grounding bus in all existing panelboards of remodeled areas, for connection of new grounding conductors, connected to an accepted ground point.

L. Bond together reinforcing steel and metal accessories in pool and fountain structures.

M. Where reinforced concrete is utilized for building grounding system, proper reinforced bonding shall be provided to secure low resistance to earth with "thermite" type devices, and #10AWG wire ties shall be provided to not less than ten (10) full length rebars which contact the connected rebar .

3.12 GROUNDING BAR/GROUND BUS (INCLUDING 'SYSTEMS' GROUND BUS/BAR ON GROUND BUS/BAR) INSTALLATION

A. Where indicated on the drawings, provide and install grounding bar/ground bus (bus bar). These bus installations are intended to provide a low-impedance "earthing" path for surge voltages, which are electrically "clamped" and shunted to earth by variable-impedance surge protective devices. Metal sheaths of underground cables are also to be grounded thereto at points of building entrance.

B. Mount bolt tapping lugs with hex head bolts to bus bar at 2" o.c. spacing, one for each ground conductor.

C. Mount bus bar to wall using 2" polyester molded insulator stand-off.

D. Extend a #2/0 (minimum size) or larger THWN insulated copper ground conductor (if larger size is called for on drawings or required by N.E.C. for service ground, etc.) in PVC conduit to accepted service ground installation or ground bus/bar in main service equipment enclosure.

E. Extend #6 insulated copper ground wire from respective bus/bar to each 'local' ground bus/bar in each cabinet for Section 27 systems.

F. 'SYSTEMS' grounding bus/bar must be connected with #2/0 insulated copper conductor to grounding electrodes system as defined in NEC "Article 800.

3.13 COMMUNICATIONS SYSTEMS

A. Provide and install all grounding as required by NEC Article 800 and where available on project: Articles 810 (Radio and Television Equipment); 820 (Community Antenna Television and Radio Distribution Systems); and 830 (Network-Powered Broadband Communications Systems.

B. Provide and install grounding electrode at point of entry of communication cables and bond to service entrance grounding electrodes per NEC 800. Install ground bus bar at point of entry of communications cable and connect electrode to ground bus. Connect communications cable metal sheath and surge protection devices to ground bar.

3.14 TESTING AND REPORTS

A. Ground resistance measurements shall be made on each system utilized in the project. The ground resistance measurements shall include building structural steel, driven grounding system, water pipe grounding system and other accepted systems as may be applicable. Ground resistance measurements shall be made in normally dry weather, not less than 24 hours after rainfall, and with the ground under test isolated from other grounds and equipment. Resistances measured shall not exceed specified limits.

B. Upon completion of testing, the testing conditions and results shall be certified and submitted to the Architect/Engineer.

END OF SECTION 260526

SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. LFNC: Liquidtight flexible nonmetallic conduit.

G. NBR: Acrylonitrile-butadiene rubber.

H. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

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

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.

2. For handholes and boxes for underground wiring, including the following:
   a. Duct entry provisions, including locations and duct sizes.
   b. Frame and cover design.
   c. Grounding details.
   d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
   e. Joint details.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.

2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

1.5 REFERENCES

A. ANSI C80.1 - Rigid Steel Conduit - Zinc Coated

B. ANSI C80.3 - Electrical Metallic Tubing - Zinc Coated

C. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

D. ANSI/NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

F. ANSI/NFPA 70 - National Electrical Code

G. NECA Standard Practices for Good Workmanship in Electrical Contracting

H. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit.

I. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit (EPC 40, EPC 80)

J. NEMA TC 3 -Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

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.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Minimum Trade Size

1. All Conduit - 3/4"c.

B. RIGID METALLIC CONDUIT

1. Comply with:
   a. ANSI C80.1
   b. UL Spec - No. 6
   c. NEC 344

2. Conduit material:
   a. Hot dipped galvanized steel.

3. Fittings:
   a. Threaded.
   b. Insulated bushings shall be used on all rigid steel conduits terminating in panels, boxes, wire gutters, or cabinets, and shall be impact resistant plastic molded in an irregular shape at the top to provide smooth insulating surface at top and inner edge. Material in these bushings must not melt or support flame.
   c. Hot dipped galvanized malleable iron or steel.

4. Conduit Bodies:
   a. Comply with ANSI/NEMA FB 1.
   b. Threaded hubs.
   c. Hot-dipped galvanized malleable iron.

C. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with:
   a. UL 6
   b. ANSI C80.1
   c. NEC. 344

d. NEMA RN1

2. Conduit material: Hot-dipped galvanized rigid steel with external PVC coating, 20 mil. thick.

3. Fittings:
   a. Threaded.
   b. Insulated bushings on terminations.
   c. Hot-dipped galvanized malleable iron or steel with external PVC coating, 20 mil. thick.

4. Conduit bodies:
   a. Comply with:
   b. ANSI/NEMA FB 1
   c. Threaded hubs
   d. Hot-dipped galvanized malleable iron with external PVC coating 20 mil thick.

D. EMT: ANSI C80.3.

1. Comply with:
   a. UL 797
   b. ANSI C80.3
   c. NEC 358
   d. ANSI/UL797

2. Conduit material: Galvanized steel tubing.

3. Fittings:
   a. ANSI/NEMA FB 1
   b. Set screw, Steel for Interior Dry locations
   c. Compression, Steel for all damp locations

E. FMC: Hot dipped galvanized.

1. Comply with:
   a. NEC 348
   b. ANSI/UL 1

2. Conduit material: Steel, interlocked.

3. Fittings:
   a. ANSI/NEMA FB 1
   b. ANSI/UL 514B
   c. Die Cast
   d. Threaded rigid conduit to flexible conduit coupling.
   e. Direct flexible conduit bearing set screw type not acceptable.

F. LFMC: Flexible steel conduit with PVC jacket.

1. Comply with:
   a. NEC 350
   b. ANSI/UL 360

2. Conduit material:
   a. Flexible hot-dipped galvanized steel core, interlocked.
   b. Continuous copper ground built into core up to 1-1/4" size.
   c. Extruded polyvinyl gray jacket.

3. Fittings:
   a. Threaded for rigid conduit connections.
   b. Accepted for hazardous locations where so installed.
   c. Provide sealing washer in wet/damp locations.
   d. Compression type.
   e. ANSI/NEMA FB 1.
   f. ANSI/UL 5148.
   g. Zinc plated malleable iron or steel.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Minimum Trade Size – ¾”

B. RNC: NEMA TC 2, Schedule-40-PVC, unless otherwise indicated.

1. Comply with:
   a. NEMA TC-2
   b. UL 651
   c. NEC 352

2. Conduit material:
   a. Shall be high impact PVC - tensile strength 55 PSI, flexural strength 11000 PSI.

3. Fittings:
   a. Comply with: NEMA TC-3 and UL 514.

2.3 EXPANSION FITTINGS

A. Aluminum products and materials including, but not limited to, raceways, boxes, and fittings are not acceptable or permitted.

B. Expansion fittings shall be:

1. UL Listed, hot dipped galvanized inside and outside providing a 4" expansion chamber - when used with rigid conduit and electrical metallic conduit, or:

2. Be polyvinyl chloride and shall meet the requirements of and as specified elsewhere for non-metallic conduit and shall provide a 6" expansion chamber.

3. Hot dipped galvanized expansion fitting shall be provided with an external braided grounding and bonding jumper with accepted clamps, UL Listed for the application.

4. Expansion fitting, UL Listed for the application and in compliance with the National Electrical Code without the necessity of an external bonding jumper may be considered. Submit fitting with manufacturer's data and UL Listing for acceptance prior to installation.

2.4 METAL WIREWAYS

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.

2. Hoffman.

3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

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.

E. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.

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. Thomas & Betts Corporation.
   b. Walker Systems, Inc.; Wiremold Company (The).
   c. Wiremold Company (The); Electrical Sales Division.
   d. Mono-Systems, Inc.

2.6 BOXES, ENCLOSURES, AND CABINETS

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 Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch (13 mm) male fixture studs where required.
2. Concrete Ceiling Boxes: Concrete type.
3. All pull boxes, junction boxes and outlet boxes to be pre-punched boxes with correct KO ratings.
4. Interior flush outlet boxes shall be one piece galvanized steel constructed with stamped knockouts in back and sides, and threaded holes with screws for securing box coverplates or wiring devices.
5. Ceiling outlet boxes shall be 4" octagonal or 4" square X 1 1/2" deep or larger as required for number and size of conductors and arrangement, size and number of conduits terminating at them.

6. Switch, wall receptacle, and other recessed wall outlet boxes, except data and telephone boxes, in drywall shall be a minimum of 4" square X 1 1/2" deep. For recessing in exposed masonry, provide one piece 4" square x 1 1/2" deep wall boxes with appropriate 4" square cut tile wall covers. For recessing in furred-out block walls, provide 4" square box with required extension for block depth and required extension for drywall depth.

7. Data and telephone boxes shall be a minimum of 4 11/16" square X 2 1/8" deep.

8. Boxes shall be of such form and dimensions as to be adapted to the specific use and location, type of device or fixtures to be used, and number and size of conductors and arrangement, size and number of conduits connecting thereto.

9. Handy boxes shall not be used for any purpose.

10. Where a box is used as the sole support for a ceiling paddle fan, the box must be listed for this purpose and the weight of the fan.

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

1. Interior surface outlet boxes and conduit bodies installed from 0" AFF to 90" AFF (including fire alarm device backbox) shall iron with external threaded hubs for power devices and threaded parts for low voltage devices. Trim rings shall also be of one-piece construction.

2. Weatherproof outlet boxes shall be constructed of corrosion-resistant cast metal suited to each application and having threaded conduit hubs, cast metal faceplate with spring-hinged waterproof cap suitable configured, gasket, and corrosion-proof fasteners.

3. Freestanding cast boxes are to be type FSY (with flange). Other cast zinc boxes are not acceptable.

D. Floor Boxes:

1. For all slab on grade areas except wet locations and wooden floors: Cast iron or steel with epoxy paint, fully adjustable before and after the concrete pour. The cover shall provide protection from water, dirt and debris. The box shall be capable of adapting to most power and communications needs. Provide all activations, barriers and brackets required for the particular installation. Design Selection is Wiremold RFB 4 (based on required outlets) or equal.

2. Wood Floors: Cast iron or steel fully adjustable, rectangular, multi-gang box. The cover shall provide protection from water, dirt and debris. The cover will be brass flip lids with appropriate multi gang ring to set flush with wood flooring. The box shall be capable of adapting to most power and communications needs.

3. Poke Thru’s for all floor boxes in elevated slabs: Flush style round poke thru with combination power (2 duplex) and data (6 Cat6 outlets). Poke Thru shall be UL scrub water exclusion for tile and carpeted floors. Poke thru shall be maintains

UL fire rated for up to 2 hour rated floors. Poke thru shall meet FBC and ADA accessibility guidelines.

E. Sheet Metal Pull and Junction Boxes: NEMA OS 1.

1. Pull and junction boxes (not in-ground type) larger than 25 square inches shall be hinged cover type with flush latches operated with screwdriver.

2. Large Pull Boxes: Boxes larger than 400 cubic inches in volume or 20 inches in any dimension:
   a. Use continuous hinged enclosures with locking handle.

3. Exterior, damp location and wet location pull and junction boxes shall be Nema 4x stainless steel.

F. Cabinets (Control and Systems):

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. Metal barriers to separate wiring of different systems and voltage.

4. Accessory feet where required for freestanding equipment.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Concrete ring with Nema 6P box inside (All Areas)

1. Color of Frame and Cover: Gray.

2. Configuration: Concrete ring shall be designed for flush burial and have open bottom, unless otherwise indicated.

3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural traffic load rating consistent with enclosure.

4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

5. Cover Legend: Molded lettering, "ELECTRIC.", "TELEPHONE." or as indicated for each service.

6. Nema 6P box rated for direct burial enclosure shall be located inside the concrete ring for termination of conduits.

7. Handholes 36 inches wide by 36 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

PART 3 - EXECUTION

3.1 RACEWAY LOCATION INSTALLATION REQUIREMENTS

A. Underground Installations:

1. Use rigid non-metallic conduit (PVC) only unless local authority having jurisdiction or applicable codes/utility requirements, etc. require rigid steel conduit.

2. All conduits or elbows entering, or leaving the ground shall be rigid steel conduit coated with asphaltic paint.

3. All underground raceways (with exception of raceways installed under floor slab) shall be installed in accordance with the NEC except that the minimum cover for any conduit shall be two feet. Included under this Section shall be the responsibility for verifying finished lines in areas where raceways will be installed underground before the grading is complete.

4. Where rigid metallic conduit is installed underground as noted above it shall be coated with waterproofing black mastic before installation, and all joints shall be re-coated after installation.

5. Utilize rigid steel 90° elbows at each riser and at each change in direction. Elbows shall be coated with black mastic or PVC coating. Bond all metal elbows per NEC.

6. All underground service lateral raceways shall be protected as required by the NEC including requirements for installation of warning tape.

B. In Slab Above or on Grade:

1. Use coated rigid steel conduit or rigid non-metallic conduit.

2. Coating of metallic conduit to be black asphaltic or PVC.

C. Penetration of Slab:

1. Exposed Location subject to damage:
   a. Where penetrating a floor in an exposed location subject to damage from underground or in slab, a black mastic coated or PVC coated galvanized rigid steel conduit shall be used.

2. Interior Location not subject to damage:
   a. Where penetrating a floor in a location concealed in block wall and acceptable by applicable codes, rigid non-metallic conduit may be used up to first outlet box, provided outlet box is at a maximum height of 40" above finished floor.

b. Where penetrating a floor in location other than that above, transition to metallic conduit at the floor.

D. Outdoor Location:

1. Above Grade:
   a. Where penetrating the finished grade, black mastic coated or PVC coated galvanized rigid steel conduit shall be used.
   b. In general all exterior conduit runs shall be rigid steel conduit and threaded connectors as specified elsewhere.
   c. RGS or IMC is permitted under roof, overhangs, etc. provided it is not subjected to physical damage and is not in direct contact or directly subject to exterior elements including sunlight.

2. Metal Canopies:

   a. Conduit runs except for canopy lighting raceways are not to be run on (top or bottom) of metal canopies roof systems. All new conduit shown on or at these areas is to be run underground. Clamp back spacers shall be used on all canopies to prevent galvanic action from dissimilar metals. Conduits installed exposed from Building structure to Metal Canopies will not be permitted.

3. Roofs:
   a. Conduit is not to be installed on roofs, without written authorization by A/E and the Owner for specific conditions.
   b. When accepted by written authorization conduit shall comply with the following:

      1) Be PVC coated rigid galvanized metal conduit.
      2) All fittings, etc. are to be PVC coated.
      3) Conduit shall be supported above roof at least 6 inches using accepted conduit supporting devices. Refer to applicable sections of specifications on roofing, etc.
      4) Supports to be fastened to roof using roofing adhesive or means compatible with roofing. Confirm the method used will not void the roofing warranty. The use of pitch pockets is not acceptable.

E. Interior Dry Locations:

1. Concealed: Use rigid galvanized steel conduit and electrical metallic tubing. Rigid non-metallic conduit may be used inside block walls up to first outlet to a maximum of 40" A.F.F. except where prohibited by the NEC (places of assembly, etc.).

2. Exposed: Use rigid galvanized steel or electrical metallic tubing. EMT may only be used where not subject to damage, which is interpreted by this specification to be above slab.

3. Concealed or exposed flexible conduit:

a. Concealed flexible steel conduit or seal tight flexible steel conduit in lengths not longer than six (6) feet in length with a ground conductor installed in the conduit or an equipment ground conductor firmly attached to the terminating fitting at the extreme end of the flex. Exposed flexible steel conduit or seal tight flexible steel conduit shall not exceed two (2) feet in length, unless written authorization by A/E for specific conditions is granted.

F. Interior Wet and Damp Locations:

1. Use rigid galvanized steel conduit.

G. Concrete Columns or Poured in-place Concrete Wall Locations:

1. Use rigid non-metallic conduit. Penetration shall be by accepted metal raceway (i.e. metal conduit as required elsewhere in these specifications).

3.2 RACEWAY INSTALLATION

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

B. All bending, cutting, and reaming shall be completed with tools specifically designed for the specific use.

C. Expansion fittings shall be installed in the following cases:

1. In each conduit run wherever it crosses an expansion joint in the concrete structure; on one side of joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion equal to at least three times the normal width of joints.

2. In each conduit run which mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other.

3. In straight conduit run above ground which is more than one hundred feet long and interval between expansion fittings in such runs shall not be greater than 100 feet.

D. Arrange conduit to maintain headroom and present neat appearance.

E. Provide rigid steel long radius 90 degree sweeps (bend radius of 10 times the conduit trade size diameter) for all changes in direction (vertical and horizontal) for utility conduits. Comply with all installation requirements of the utility to utilize the conduits.

F. Utility conduits shall be buried a minimum of 36” deep to the top of the conduit.

G. Route conduit installed above accessible ceilings or exposed to view parallel or perpendicular to walls. Do not run from point to point.

H. Do not cross conduits in slab.

I. Use conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

J. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

K. Complete raceway installation before starting conductor installation.

L. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

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

N. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2 inch (50 mm) size.

O. Provide continuous fiber polyline 1000 lb. minimum tensile strength pull string in each empty conduit except sleeves and nipples. This includes all raceways which do not have conductors furnished under this Division of the specifications. Pull cord must be fastened to prevent accidental removal.

P. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

Q. Rigid steel box connections shall be made with double locknuts and bushings.

R. Spare conduit stubs shall be capped and location and use marked with concrete marker set flush with finish grade. Marker shall be 6" round x 6" deep with appropriate symbol embedded into top to indicate use. Also, tag conduits in panels where originating.

S. Spare conduit stubs shall be capped with a UL listed and accepted cap or plug for the specific intended use and identified with ink markers as to source and labeled "Spare."

T. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

U. 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.

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

W. 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.

X. Install raceway sealing fittings at suitable, approved, and accessible locations 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 at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Where otherwise required by NFPA 70.

Y. 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.

Z. All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.

AA. Raceways shall not be routed through stairwells, elevator shafts, elevator machine rooms or fire pump rooms unless the conduit is for use within that space.

BB. Raceways installed in hazardous locations shall be installed in accordance with the appropriate provisions of NEC chapter 5 for that location. Confirm the appropriate space rating with life safety plans.

CC. All raceway runs, whether terminated in boxes or not, shall be capped during the course of construction and until wires are pulled in, and covers are in place. No conductors shall be pulled into raceways until construction work which might damage the raceways has been completed.

DD. Electrical raceways shall be supported independently of all other systems and supports, and shall in every case avoid proximity to other systems which might cause confusion with such systems or might provide a chance of electrolytic actions, contact with live parts or excessive induced heat.

EE. Excavate trench bottom to provide firm and uniform support for conduit installed underground. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter. Install backfill as specified in Division 31 Section "Earth Moving."

FF. After installing underground conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."

3.3 BOX INSTALLATION

A. Parallel or perpendicular to building columns or structure.

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

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

D. Install electrical boxes as shown on drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

E. Install electrical boxes to maintain headroom and to present neat mechanical appearance.

F. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches (150 mm) from ceiling access panel or from removable recessed luminaire.

G. Install boxes to preserve fire resistance rating of partitions and other elements.

H. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.

I. Outlets for 120V clocks shall be recessed so that the clock will hang flush with the finished surface of the wall.

J. Use flush mounting outlet boxes in finished areas.

K. Do not install flush mounting boxes back-to-back in walls; provide minimum 6 inch (150 mm) separation. Provide minimum 24 inches (600 mm) separation in acoustic and fire rated walls.

L. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

M. Use stamped steel bridges to fasten flush mounting outlet box between studs.

N. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

O. Support all outlet boxes from structure with minimum of one (1) 3/8" all-thread rod hangers. Boxes larger than 25 square inches shall be supported with two (2) all-thread rod hangers, minimum.

P. Do not fasten boxes to ceiling support wires.

Q. Use multi-gang box where more than one device is mounted together. Do not use sectional box.

R. Boxes in exterior walls shall be flush mounted. Use cast outlet box in exterior locations and wet locations where flush mounting is not possible.

S. Install outlets in the locations shown on the drawings; however, the Owner shall have the right to make, prior to rough-in, slight changes in locations to reflect room furniture layouts.

T. Coordinate work with all divisions so that each electrical box is the type suitable for the wall or ceiling construction provided and suitable fireproofing is inbuilt into fire rated walls.

U. All boxes shall be installed in a flush rigid manner with box lines at perpendicular and parallel angles to finished surfaces. Boxes shall be supported by appropriate hardware selected for the type of surface from which the box shall be supported. For example, provide metal screws for metal, wood screws for wood, and expansion devices for masonry or concrete.

V. For locations exposed to weather or moisture (interior or exterior), provide weatherproof boxes and accessories.

W. As a minimum, provide pull boxes in all raceways over 150 feet long. The pull box shall be located near the midpoint of the raceway length.

X. Provide knockout closures to cap unused knockout holes where blanks have been removed, and plugs for unused threaded hubs.

Y. Provide conduit locknuts and bushings of the type and size to suit each respective use and installation.

Z. Boxes and conduit bodies shall be located so that all electrical wiring is accessible.

AA. Avoid using round boxes where conduit must enter box through side of box, which would result in a difficult and insecure connection with a locknut or bushing on the rounded surface.

BB. All flush outlets shall be mounted so that covers and plates will finish flush with finished surfaces without the use of shims, mats or other devices not submitted or accepted for the purpose. Add-a-Depth rings or switch box extension rings are <u>not</u> acceptable. Plates shall not support wiring devices. Gang switches with common plate where two or more are indicated in the same location. Wall-mounted devices of different systems (switches, thermostats, etc.) shall be coordinated for symmetry when located near each other on the same wall. Outlets on each side of walls shall have separate boxes. Through-wall type boxes shall not be permitted. Back-to-back mounting shall not be permitted. Trim rings shall be extended to within 1/8" of finish wall surface.

CC. Outlet boxes mounted in metal stud walls, are to be supported to studs with two (2) screws inside of outlet box to a horizontal stud brace between vertical studs or one side of outlet box supported to stud with opposite side mounted to section of stud or device to prevent movement of outlet box after wall finished.

DD. All outlet boxes that do not receive devices in this contract are to have blank plates installed matching wiring device plates.

EE. Height of wall outlets to bottom above finished floors shall be as follows, unless specifically noted otherwise, or unless otherwise required by applicable codes including ADA. Verify with the Architectural plans and shop drawings for installing.

1.	Switches	4'-0" AFF to top
2.	Receptacles	1'-4" AFF to bottom
3.	Lighting Panels	6'-6" AFF to centerline of highest breaker/fuse
4.	Phone outlets	1'-4" AFF to bottom
5.	Intercom Call-in	4'-0"AFF to top
6.	Fire Alarm Pull Stations	4'-0" AFF to top
7.	Fire Alarm Strobe Lights	Lens is not less than 80" AFF and not more than 96” AFF
8.	Fire Alarm Audible Only	Not less than 90” and not less than 6” below ceiling.

.

FF. Bottoms of outlets above counter tops or base cabinets shall be minimum 2" above counter top or backsplash, whichever is highest. Outlets may be raised so that bottom rests on top of concrete block course, but all outlets above counters in same area shall be at same height. It is the responsibility of this Division to secure cabinet drawings and coordinate outlet locations in relation to all cabinets as shown on Architectural plans, prior to rough-in, regardless of height shown on Division 26 drawings.

GG. Height of wall-mounted fixtures shall be as shown on the drawings or as required by Architectural plans and conditions. Fixture outlet boxes shall be equipped with fixture studs when supporting fixtures.

HH. Locate special purpose outlets as indicated on the drawings for the equipment served. Location and type of outlets shall be coordinated with appropriate trades involved. The securing of complete information for proper electrical roughing-in shall be included as work required under this section of specifications. Provide plug for each outlet.

II. Electrical outlet boxes may be installed in vertical fire resistive assemblies classified as fire/smoke and smoke partitions without affecting the fire classification, provided such openings occur on one side only within a 24” wall space and that openings do not exceed 16 sq. inches. All clearances between such outlet boxes and the gypsum board must be completely filled with joint compound.

JJ. Fire-Barrier Penetrations: Firestop penetrations under division 07 Section “Firestopping”.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In all areas, set so cover surface will be flush with finished grade.

3.5 INSTALLATION OF WIREWAYS

A. Do not install wireways as a substitute for proper coordination and layout of conduit stub ups to panels. Prior authorization from the engineer is required prior to installation of any wireways.

B. Do not make splices in wireways. All wires must be pulled through without splice or termination.

C. Install wireway to maintain headroom and to present neat mechanical appearance.

D. Support wireway independently of conduit.

E. Wireway shall be located so that all electrical wiring is accessible.

END OF SECTION 260533

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Identification for raceway and metal-clad cable.
2. Identification for conductors and communication and control cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by

codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

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

PART 2 - PRODUCTS

2.1 RACEWAY, BOX AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

B. Primed and Painted band 4” in length.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

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

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1. Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).

C. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS

A. Safety Signs: Comply with 29 CFR, 1910.145.

B. Nameplates shall be laminated phenolic plastic, chamfer edges.

1. For 120/208 Volt System:

a. Black front and back with white core, with lettering etched through the outer covering. White engraved letters on Black background.

2. For 277/480 Volt System:

a. Orange front and back with white core with lettering etched through the outer covering. White engraved letters on Orange background.

3. For Emergency System:

a. Red front and back with white core with lettering etched through the outer covering. White engraved letters on red background.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.6 kg), minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.

C. 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 INSTALLATION

A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before applying.

E. Install painted identification according to manufacturer's written instructions and as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.
2. Prime surfaces using type of primer specified for surface.
3. Apply one intermediate and one finish coat of enamel.

F. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.

G. Circuit Identification Labels on Boxes: Install labels externally.

1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
2. Concealed Boxes: Plasticized card-stock tags.
3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

H. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground line marker located directly above line at 6 to 8 inches below finished grade. Where width of multiple lines installed in a common trench or concrete

envelope does not exceed 16 inches overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

I. Secondary Service, Feeder, and Branch-Circuit Conductors: Color-code throughout the secondary electrical system.

1. Color-code 208/120-V system as follows:

a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.
d. Neutral: White.
e. Ground: Green.
f. Switchlegs(load side of contactor or relay is not considered a switchleg): Purple

2. Color-code 480/277-V system as follows:

a. Phase A: Brown
b. Phase B: Orange
c. Phase C: Yellow
d. Neutral: **Gray**.
e. Ground: Green.
f. Switchleg(load side of contactor or relay is not considered a switchleg): Pink

3. **Factory apply color the entire length of conductors**.

J. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and switchboard rooms.

1. Legend: 1/4-inch steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
2. Tag Fasteners: Nylon cable ties.
3. Band Fasteners: Integral ears.

K. Apply identification to conductors as follows:

1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

L. Apply warning, caution, and instruction signs as follows:

1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install

engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

M. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

N. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.

O. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Engraved, laminated acrylic or melamine label. 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 2 lines of text are required, use labels 2 inches (50 mm) high.
b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled: Include as a minimum the equipment identification (first line ½”): voltage rating and amperage rating (second line 3/8”): where it is fed from (third line 3/8”). (Example :Panel CP1 (Line 1), 208/120V 3ph, 4w, 225A(line 2), fed from swbd MDP-1 (Line 3))

a. Panelboards, electrical cabinets, and enclosures.
b. Access doors and panels for concealed electrical items.
c. Electrical switchgear and switchboards.
d. Transformers.
e. Electrical substations.
f. Emergency system boxes and enclosures.
g. Motor-control centers.
h. Disconnect switches.
i. Enclosed circuit breakers.

j. Motor starters.
k. Push-button stations.
l. Power transfer equipment.
m. Contactors.
n. Remote-controlled switches, dimmer modules, and control devices.
o. Battery inverter units.
p. Battery racks.
q. Power-generating units.
r. Voice and data cable terminal equipment.
s. Master clock and program equipment.
t. Intercommunication and call system master and staff stations.
u. Television/audio components, racks, and controls.
v. Fire-alarm control panel and annunciators.
w. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
x. Monitoring and control equipment.
y. Uninterruptible power supply equipment.
z. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.2 SWITCHGEAR BREAKERS

A. Provide labels for each breaker to identify the load served.

3.3 CONDUIT/JUNCTION BOX COLOR CODE

A. All conduit system junction boxes (except those subject to view in public areas) shall be color coded as listed below:

B. Color Code for Junction Boxes

1.	System Emergency 277/480 volt	Orange/Brown
2.	System Emergency 120/208 volt	Orange/Black
3.	Fire Alarm	Red
4.	Normal Power 277/480 volt	Brown
5.	Normal Power 120/208 volt	Black
6.	Fiber Optics	Purple
7.	Sound System	Yellow
8.	Clock	Light Blue
9.	Intercom	Blue
10.	Computer/Data	Gold
11.	TV	White
12.	Security/CCTV	Beige
13.	Ground	Fluorescent Green
14.	Telephone	Clover Green

C. Conduits (not subject to public view) longer than 20 feet shall be painted with above color paint band 30 ft. on center. Paint band shall be 4” in length. Where conduits are parallel and on conduit racking, the paint bands shall be evenly aligned. Paint shall be

neatly applied and uniformed. Paint boxes and raceways prior to installation or tape conduits and surrounding surfaces to avoid overspray. Paint overspray shall be removed.

D. All new and existing junction boxes/cover plates for power, lighting and systems (except those installed in public areas) shall adequately describe it's associated panel and circuit reference number(s) within, (i.e. ELRW-2, 4, 6) or systems within (i.e. fire alarm, intercom. Etc.). Identification shall be by means of black permanent marker. (Paint ½ cover plate with appropriate color as noted in 2.3 above, and mark other ½ with associated panel/circuit or system description as described).

END OF SECTION 260553

SECTION 26 08 16
DEMONSTRATION OF COMPLETED ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 PERFORMANCE REQUIREMENTS

A. Purpose:
   1. This section includes the requirements for demonstration of completed electrical systems; requirements of this section are in addition to any other related section.

B. Demonstrate to the Owner the essential features of the following electrical systems:
   1. Communications Systems
      a. All systems included in DC Sections 27 and 28.
   2. Electrical Entrance Equipment
      a. Circuit Breakers
      b. Fuse and fuseholders
      c. Meters (where applicable)
   3. Miscellaneous Electrical Equipment
      a. Kitchen exhaust hood shut down
      b. Electrical systems controls and equipment
      c. Electrical power equipment
      d. Motor control devices
      e. Relays
      f. Special transformers
      g. Starting devices
      h. Surge suppression equipment
   4. Lighting Fixtures (including relamping and replacing lenses)
      a. Exit and safety fixtures
      b. Fixtures, indoor and outdoor
   5. Distribution Equipment
      a. Lighting and appliance panelboards
      b. Distribution panels
      c. Switchboards
   6. Stand-by Electrical Equipment
      a. Batteries
      b. Battery chargers
      c. Controls and alarms
      d. Emergency generators, transfer switches
   7. Wiring Devices
      a. Low-voltage controls
      b. Switches: regular, time
      c. Upon completion of testing, each system is to be demonstrated only once.
      d. The demonstration is to be held upon completion of all systems at a date to be agreed upon in writing by the Owner or his representative.
      e. The demonstration is to be scheduled and performed by this Contractor in the presence of the Owner, and the manufacturer's representative.

1.2 DEMONSTRATION

A. Demonstrate the function and location (in the structure) of each system, and indicate its relationship to the riser diagrams and drawings.

B. Demonstrate by “start-stop operation” how to work the controls, how to reset protective devices, how to replace fuses, and what to do in case of emergency.

1.3 COORDINATION / EXHIBITS

A. Specification Items:
   a. Exhibit 1 – Check Out Memo Form

END OF SECTION 260816

CHECK OUT MEMO FORM

This form shall be completed and a copy provided to the Owner at the Owner's Performance Verification and Demonstration Meeting. A copy shall also be included in the specification section of each O & M Manual for the equipment checked.

Project Name: _____

Type of Equipment Checked: _____

Equipment Number: _____

Name of manufacturer of equipment: _____

Signature below by the manufacturer's authorized representative signifies that the equipment has been satisfactorily tested and checked out on the job by the manufacturer.

1. The attached Test and Data and Performance Verification information was used to evaluate the equipment installation and operation.
2.
3. The equipment is properly installed, has been tested by the manufacturer's authorized representative, and is operating satisfactorily in accordance with all requirements, except for items listed below.*
4.
5. Written operating and maintenance information has been presented to the Contractor, and gone over with him in detail.
6.
7. Sufficient copies of all applicable operating and maintenance information, parts lists, lubrication checklists, and warranties have been furnished to the contractor for insertion in the Operation and Maintenance Manuals.

Checked By: _____
(Print or Type Nam of Manufacturer's Representative)

Address: _____
(Address and Phone No. of Representative)

Signature: _____
(Title of Representative)

Date Checked: _____

Witnessed By: _____
(Signature and Title of Contractor Representative)

*Exceptions Noted at Time of Check-Out (use additional page if necessary):

EXHIBIT 1

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Twist-locking receptacles.
   3. Isolated-ground receptacles.
   4. Snap switches and wall-box dimmers.
   5. Solid-state fan speed controls.
   6. Pendant cord-connector devices.
   7. Cord and plug sets.
   8. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

B. Related Sections include the following:
   1. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

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

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

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

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. 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.

C. Comply with NFPA 70.

D. Comply with NEMA WD 1.

1.6 COORDINATION

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

1.7 ALLOWANCES

A. Provide for twenty additional receptacles as directed in field. Allowance includes purchase, delivery and installation of box, receptacle cover plate, wire and 100 feet of conduit for each receptacle.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   2. Leviton Mfg. Company Inc. (Leviton).
   3. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498, **back wired**.
   1. Products: Subject to compliance with requirements, provide one of the following for standard convenience outlets:

a. Hubbell; HBL5361 (single), HBL5352 (duplex).
b. Leviton; 5351 (single), 5352 (duplex).
c. Pass & Seymour; 5361 (single), 5352 (duplex).

2. Black Computer Power Duplex Receptacle:
   a. Pass & Seymour Model PS5352-Black
   b. Hubbell Model HBL5362-Black
   c. Leviton Model 5362-Black

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, **back wired**, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and trip button to indicate when device is tripped. Face will not have power if reverse wired. Visual indication for device has lost capability to provide protection.

B. Outdoor locations provide weather resistant GFCI convenience receptacles, 125V, 20A - Black
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell #GFR5362WR
      b. Pass & Seymour; 2095DSWRBK.
      c. Leviton #W7899-E

C. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell #GFR5362
      b. Pass & Seymour; 2095.
      c. Leviton #6898

2.4 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Snap switches for general use shall be maintained contact types, and shall be single-pole, double-pole, three-way, or four-way as required for the specific switching arrangements shown on the drawings. They shall be quiet tumbler operation types, having silver alloy contacts, and meeting all NEMA performance standards, **back wired**.

C. Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; HBL1221 (single pole), HBL1222 (two pole), HBL1223 (three way), HBL1224 (four way).
      b. Leviton; 1221 (single pole), 1222 (two pole), 1223 (three way), 1224 (four way).
      c. Pass & Seymour; PS20AC1 (single pole), PS20AC2 (two pole), PS20AC3 (three way), PS20AC4 (four way).

2. Description: Single pole, with factory-supplied key in lieu of switch handle. All key operated switches shall be keyed alike.

D. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Hubbell; HBL1557.
b. Leviton; 1257.
c. Pass & Seymour; 1251.

2.5 WALL-BOX DIMMERS

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

B. Control: Continuously adjustable toggle switch; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
1. 600 W; dimmers shall require no derating when ganged with other devices.

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.6 FAN SPEED CONTROLS

A. Modular, 120-V, full-wave, **back wired**, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.
1. Continuously adjustable toggle switch, 5 A.
2. Three-speed adjustable slider, 1.5 A.

2.7 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
2. All wiring devices shall be provided with standard size one-piece cover plates of suitable configuration for the number and type of devices to be covered.
3. Thermoset (rigid plastic) cover plates shall be used in interior spaces.
4. Cover plate engraving, where required, shall be accomplished by cover plate manufacturer in accordance with instructions given on the drawings. Metallic plates shall be engraved with black fill. Red plates shall be engraved with white fill.
5. Material for Unfinished Spaces: Galvanized steel.
6. All cover plates shall be “standard” size. Mid-way or jumbo plates are not accepted.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable “in use” cover. Cover plates for exterior receptacles shall be gasketed covers with hinge allowing plug and cord to be plugged in and activated with cover closed.

2.8 MULTIOUTLET ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Incorporated; Wiring Device-Kellems.
   2. Wiremold Company (The).
   3. Mono-systems, Inc.

B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

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

D. Wire: No. 12 AWG.

2.9 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.
   1. Wiring Devices Connected to Normal Power System: **White**, unless otherwise indicated or required by NFPA 70 or device listing.
   2. Receptacle devices for computer power shall be black color.
   3. Wiring Devices Connected to Emergency Power System: Red.
   4. Modify any given catalog numbers as required to procure devices and plates of the proper color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. 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 the 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.

B. Install products in accordance with manufacturer's instructions.

C. Install devices plumb and level.

D. Install switches with OFF position down.

E. Provide device coverplates for every device installed. Cover plates shall be installed so that they appear straight with no gaps between plate edges and the wall. Maintain vertical and horizontal to within 1/16 of an inch

F. Wiring devices shall not be installed in exposed masonry until cleaning of masonry with acids has been completed.

G. All receptacles and switches shall be grounded by means of a ground wire from device ground screw to outlet box screw and branch circuit ground conductor. Strap alone will not constitute an acceptable ground.

H. All devices shall be installed so that only one wire is connected to each terminal.

I. All wiring devices will be back wired connected.

J. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

K. Install local room area wall switches at door locations on the lock side of the door, approximately four inches from the jamb. Where locations shown on the drawings are in question, provide written request for information to A/E prior to roughin.

L. Conductors:
   1. Do not strip insulation from conductors until just 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.

M. Device Installation:
   1. Replace all devices that have been in temporary use during construction or that show signs that they 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. All wiring devices will be back wired connected.
   6. Use a torque screwdriver when a torque is recommended or required by the 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.

N. 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.

O. Dimmers:
1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

P. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on bottom. Group adjacent switches or receptacles under multigang wall plates. Provide proper NEC barriers in boxes which serve devices for both the Normal and Emergency Systems.

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

3.2 CONNECTIONS

A. Connect wiring device grounding terminal to outlet box with bonding jumper.

B. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.

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

3.3 NEUTRAL CONDUCTOR CONNECTIONS

A. At each receptacle "in" and "out" phase and neutral conductors shall have an additional conductor for connection to device. The practice of "looping" conductors through receptacle boxes shall not be acceptable. (IE: The device shall not be used to complete the circuit. Pigtails shall be used from the device)

3.4 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."
1. Receptacles and Switches: Identify panelboard and circuit number from which served. Use permanent marker to identify on the back of plates or tags within outlet boxes.

3.5 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

3.6 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

END OF SECTION 262726

SECTION 26 28 13
FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Cartridge fuses rated 600 V and less for use in switches, controllers and motor-control centers.

1.3 SUBMITTALS

A. Product Data: Include the following for each fuse type indicated:

1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
2. Let-through current curves for fuses with current-limiting characteristics.
3. Time-current curves, coordination charts and tables, and related data.
4. Fuse size for elevator feeders and elevator disconnect switches.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from a single manufacturer.

B. 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.

C. Comply with NEMA FU 1.

D. Comply with NFPA 70.

1.5 PROJECT 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.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

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: Three (3) of each type installed. Install in spare Fuse Cabinet

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussman, Inc.
2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
3. Mersen
4. Tracor, Inc.; Littlefuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

3.2 FUSE APPLICATIONS

A. Service Entrance: Class RK1, time delay.

B. Feeders: Class RK5, time delay.

C. Motor Branch Circuits: Class RK5, time delay.

D. Other Branch Circuits: Class RK5, time delay.

3.3 INSTALLATION

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

3.4 IDENTIFICATION

A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 262813

SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following individually mounted, enclosed switches and circuit breakers:

1. Fusible switches.
2. Nonfusible switches.
3. Bolted-pressure contact switches.
4. High-pressure, butt-type contact switches.
5. Molded-case circuit breakers.
6. Molded-case switches.
7. Enclosures.

1.3 DEFINITIONS

A. GD: General duty.

B. GFCI: Ground-fault circuit interrupter.

C. HD: Heavy duty.

D. RMS: Root mean square.

E. SPDT: Single pole, double throw.

1.4 REFERENCES

A. UL 98 Enclosed and Dead Front Switches

B. NEMA KS1 Enclosed Switches

C. NEMA 250 Enclosures for Electrical Equipment

D. NFPA 70 National Electric Code

1.5 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, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current rating.
4. UL listing for series rating of installed devices.
5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current curves, including selectable ranges for each type of circuit breaker.

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.

B. Comply with NFPA 70.

C. 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.

1.7 PROJECT 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).

1.8 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces.

Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 RATING

A. The size, number of poles, and fusing for each switch shall be as denoted on the drawings. As a minimum, no less than one pole for each ungrounded conductor shall be provided. Switches shall be rated 250 VAC or 600 VAC as required by the circuit to which it is connected.

B. Switches serving motors with more than one set of windings shall have the number of poles necessary to disconnect all conductors to all windings in a single switch. Switches serving motor loads shall be horsepower rated of sufficient size to handle the load.

2.3 SERVICE ENTRANCE EQUIPMENT

A. Switches used as service entrance equipment shall be listed and labeled by U.L. for use as service equipment.

2.4 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider.

B. Fusible Switch, 1200 A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Nonfusible Switch, 1200 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two 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; and labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.5 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider.

B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. 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.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip-Unit Circuit Breakers: All breakers 400A and larger. RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.

C. Molded-Case Circuit-Breaker Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
4. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.

7. Auxiliary Switch: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
8. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
9. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

2.6 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

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.

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

3.2 INSTALLATION

A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

B. All switches shall be firmly anchored to walls and supporting structures (where used) using appropriate installation. Switches shall be installed with the turning axis of their handles approximately 5'-0" above finished floor unless otherwise indicated. Provide rigid steel (galvanized for exterior use) mounting stands, brackets, plates, hardware, and accessories for a complete installation

C. Switches shall be mounted in accessible locations chosen where the passageway to the switch is not likely to become obstructed. Where a switch serves as the disconnecting means for a load, the switch shall be located as close as practical to the load with the switch handle within sight of the load.

D. Provide and install lugs on disconnect switch as required to accept conductors called for on drawings.

E. Disconnect switches shall not be mounted on equipment, unless specifically noted or required and meet all applicable codes, etc. If switches are noted or required to be

mounted on equipment they shall have vibrator clips on fuses and be connected to conduit system with liquid tight flexible conduit.

F. Coordinate all requirements for controls between variable speed drive units and its respective motor with drive specification, manufacturer, provider and installer. Provide auxiliary contacts, relays, etc. as required.

G. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Install equipment grounding connections for switches with ground continuity to main electrical ground bus.

B. Install power wiring. Install wiring between switches and control and indication devices.

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 and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance testing as follows:

1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.
3. Verify rating of installed fuses.
4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Infrared Scanning:

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. Open or remove doors or panels so connections are accessible to portable scanner.
b. Instruments, Equipment and Reports:

    1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    2) Prepare a certified report that identifies enclosed switches and circuit breakers included and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges and record settings included in close out documents.

3.7 CLEANING

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 262816

SECTION 26 29 13
ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:

1. Across-the-line, manual and magnetic controllers.
2. Reduced-voltage controllers.
3. Multispeed controllers.

B. Related Sections include the following:

1. Division 26 Section "Variable-Frequency Motor Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on constant torque loads in ranges up to 200 hp.
2. Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for low-voltage power, control, and communication surge suppressors.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each enclosed controller.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Nameplate legends.
c. Short-circuit current rating of integrated unit.
d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.

e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Operation and Maintenance Data: For enclosed controllers to include in operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

E. 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.

F. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

B. 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.

C. Comply with NFPA 70.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.6 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
2. Eaton Corporation; Cutler-Hammer Products.
3. General Electrical Company; GE Industrial Systems.
4. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
5. Siemens/Furnas Controls.
6. Square D.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."

1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 20 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.

1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
3. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
4. Hand – Off – Auto Selector Switch: Include with each starter a NEMA ICS 2, heavy duty oil tight selector switch with legend plate.
5. Run Light: Include with each starter a NEMA ICS 2, heavy duty oil tight push to test green pilot light to indicate when the motor is running.
6. Auxiliary Contacts: Include 2 NO/2NC contacts for status of each starter.

C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.

1. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
3. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
4. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide

relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
5. Hand – Off – Auto Selector Switch: Include with each starter a NEMA ICS 2, heavy duty oil tight selector switch with legend plate.
6. Run Light: Include with each starter a NEMA ICS 2, heavy duty oil tight push to test green pilot light to indicate when the motor is running.
7. Auxiliary Contacts: Include 2 NO/2NC contacts for status of each starter.

2.3 REDUCED-VOLTAGE ENCLOSED CONTROLLERS

A. Star-Delta Controller: NEMA ICS 2, closed transition with adjustable time delay.

B. Part-Winding Controller: NEMA ICS 2, closed transition with separate overload relays for starting and running sequences.

C. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition.

D. Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.

1. Adjustable acceleration rate control utilizing voltage or current ramp, and adjustable starting torque control with up to 500 percent current limitation for 20 seconds.
2. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
3. LED indicators showing motor and control status, including the following conditions:

    a. Control power available.
    b. Controller on.
    c. Overload trip.
    d. Loss of phase.
    e. Shorted silicon-controlled rectifier.

4. Automatic voltage-reduction controls to reduce voltage when motor is running at light load.
5. Motor running contactor operating automatically when full voltage is applied to motor.
6. Hand – Off – Auto Selector Switch: Include with each starter a NEMA ICS 2, heavy duty oil tight selector switch with legend plate.
7. Run Light: Include with each starter a NEMA ICS 2, heavy duty oil tight push to test green pilot light to indicate when the motor is running.
8. Auxilary Contacts: Include 2 NO/2NC contacts for status of each starter.

2.4 MULTISPEED ENCLOSED CONTROLLERS

A. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:

1. Compelling relay to ensure that motor will start only at low speed.
2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
3. Decelerating relay to ensure automatically timed deceleration through each speed.
4. Hand – Off – Auto Selector Switch: Include with each starter a NEMA ICS 2, heavy duty oil tight selector switch with legend plate.
5. Run Light: Include with each starter a NEMA ICS 2, heavy duty oil tight push to test green pilot light to indicate when the motor is running.
6. Auxilary Contacts: Include 2 NO/2NC contacts for status of each starter.

2.5 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 4X.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4x.
4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.6 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.

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

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Install freestanding equipment on concrete bases.

3.4 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.

3.5 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.6 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

3.7 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Coordinate conduit installation with acceptable conduit entrance locations of the supplied controller.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection, except optional tests, stated in NETA ATS, Motor Control - Motor Starters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

END OF SECTION 262913

SECTION 26 29 23
VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes solid-state, PWM, VFCs for speed control of three-phase, squirrel-cage induction motors.

B. Related Sections include the following:
   1. Division 26 Section "Surge Protection Devices" for low-voltage power, control, and communication surge suppressors.

1.3 DEFINITIONS

A. BMS: Building management system.

B. IGBT: Integrated gate bipolar transistor.

C. LAN: Local area network.

D. PID: Control action, proportional plus integral plus derivative.

E. PWM: Pulse-width modulated.

F. VFC: Variable frequency controller.

1.4 SUBMITTALS

A. Product Data: For each type of VFC. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. Shop Drawings: For each VFC.

   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

      a. Each installed unit's type and details.

b. Nameplate legends.
c. Short-circuit current rating of integrated unit.
d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
e. Features, characteristics, ratings, and factory settings of each motor-control center unit.

2. Wiring Diagrams: Power, signal, and control wiring for VFCs. Provide schematic wiring diagram for each type of VFC.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Operation and Maintenance Data: For VFCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for VFCs and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

E. 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.

F. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain VFCs of a single type through one source from a single manufacturer.

B. 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.

C. Comply with NFPA 70.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, minimum clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver VFCs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Store VFCs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subject to weather, cover VFCs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:

1. Ambient Temperature: 0 to 40 deg C.
2. Humidity: Less than 90 percent (noncondensing).
3. Altitude: Not exceeding 3300 feet (1005 m).

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

1.8 COORDINATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

D. Coordinate features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
2. Eaton Corporation; Cutler-Hammer Products.
3. General Electric Company; GE Industrial Systems.
4. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
5. Siemens Energy and Automation; Industrial Products Division.
6. Square D.
7. Emerson Electric
8. Toshiba International Corporation.
9. Trane

2.2 VARIABLE FREQUENCY CONTROLLERS

A. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

B. 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.

C. Unit Operating Requirements:

1. Input ac voltage tolerance of 208 V, plus or minus 5 percent and 380 to 500 V, plus or minus 10 percent.
2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
3. Minimum Efficiency: 96 percent at 60 Hz, full load.
4. Minimum Displacement Primary-Side Power Factor: 96 percent.
5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
6. Starting Torque: 100 percent of rated torque or as indicated.
7. Speed Regulation: Plus or minus 1 percent.

D. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

1. Electrical Signal: 4 to 20 mA at 24 V.

E. 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: 2 to a minimum of 22 seconds.

4. Deceleration: 2 to a minimum of 22 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

F. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors.
2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 20 performance.
4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
5. Instantaneous line-to-line and line-to-ground overcurrent trips.
6. Loss-of-phase protection.
7. Reverse-phase protection.
8. Short-circuit protection.
9. Motor overtemperature fault.

G. Memory: Controller shall permanently maintain all input data including but not limited to motor data, trip parameters, time/date, fault log, etc. Battery may be used for time date ride thru of power outage for a minimum of 72hours.

H. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.

I. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

J. 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.

K. 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.

L. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

M. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

N. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

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 (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

O. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:

   a. 0 to 10-V dc.
   b. 0-20 or 4-20 mA.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
   e. RS485.
   f. Keypad display for local hand operation.

3. Output Signal Interface:

   a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

      1) Output frequency (Hz).
      2) Output current (load).
      3) DC-link voltage (VDC).
      4) Motor torque (percent).
      5) Motor speed (rpm).
      6) Set-point frequency (Hz).

4. Remote Indication Interface: A minimum of 2 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.

P. Line Reactor: Provide drive with UL listed 5% input line reactor to help prevent drive component damage, reduce nuisance tripping caused by utility capacitor switching and provide harmonic mitigation. Reactor shall be TCI KDR high Z or equal.

Q. Communications: Provide an RS485 interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

R. Manual Bypass: Magnetic contactor arranged to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass selector switch sets mode, and indicator lights give indication of mode selected. Unit shall be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller (no load).

S. Bypass Controller: NEMA ICS 2, full-voltage, nonreversing enclosed controller with across-the-line starting capability in manual-bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.

T. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

U. Isolating Switch: Non-load-break switch arranged to isolate VFC and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

V. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.3 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 4X.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4x.
4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.4 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. 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.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Standard Displays:

1. Output frequency (Hz).
2. Set-point frequency (Hz).
3. Motor current (amperes).
4. DC-link voltage (VDC).
5. Motor torque (percent).
6. Motor speed (rpm).
7. Motor output voltage (V).

F. 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.

G. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VFCs before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

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

3.2 APPLICATIONS

A. Select features of each VFC to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. Anchor each VFC assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

B. Install VFCs larger than 9 cubic feet on concrete bases.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."

3.4 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Common Work Results for Electrical," and concrete materials and installation requirements are specified in Division 03.

3.5 IDENTIFICATION

A. Identify VFCs, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

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 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

3.7 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
3. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection, except optional tests, stated in NETA ATS.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency controllers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 262923

SECTION 28 31 11
ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS

A. LED: Light-emitting diode.

B. NICET: National Institute for Certification in Engineering Technologies.

C. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.3 STANDARDS, CODES, REFERENCES, AND REGULATORY REQUIREMENTS

A. Equipment and installation shall comply with the current or applicable provisions of the following standards:

1. ANSI S3.41 American National Standard Audible Emergency Evacuation Signal
2. NFPA 70 National Electric Code (including but not limited to Article 760, Fire Alarm Systems, Article 770 and Article 800)
3. NFPA 72 National Fire Alarm Code
4. NFPA 101 Code For Safety to Life from Fire in Buildings and Structures
5. NFPA 90A Installation of Air Conditioning and Ventilating Systems
6. NFPA 96 Ventilation Control and Fire Protection of Commercial Cooking Operations
7. Underwriters Laboratories Inc. System and all components shall be listed by Underwriters Laboratories Inc. for use in fire protective signaling system under the following standards as applicable:
8. UL 864 (Category UOJZ) APOU Control Units for Fire Protective Signaling Systems. All Control Equipment shall be listed under UL category UOJZ.
9. UL 268 Smoke Detectors for Fire Protective Signaling Systems
10. UL 268A Smoke Detectors for Duct Applications
11. UL 217 Smoke Detectors Single Station
12. UL 521 Heat Detectors for Fire Protective Signaling Systems
13. UL 228 Door Holders for Fire Protective Signaling Systems
14. UL 464 Audible Signaling Appliances
15. UL 1638 Visual Signaling Appliances
16. UL 1481 Power Supplies for Fire Protective Signaling Systems
17. UL 1480 Speakers
18. UL 1424 Cables

19. UL 1971 Signaling Devices for the Hearing Impaired
20. U.L. 1449 - Standard for Safety, Transient Voltage Surge Suppressors.
21. U.L. 497, U.L. 497A, U.L. 497B.
22. IEEE: Fire alarm system includes solid state electronic components. Therefore, the equipment manufacturer shall provide certification that all such equipment is internally protected from, or can withstand, power line surge voltages and currents as specified in Table 1, Location Category A High Exposure of ANSI/IEEE Standard C62.41-2002 (formerly IEEE Standard 587).

B. Equipment and installation shall comply with the current or applicable provisions of the following codes and laws:
1. Americans with Disabilities Act (ADA): The fire alarm system shall comply with ADA, Public Law 101-336, 1990. The system shall comply with ADA Accessibility Guidelines (ADAAG).
2. Federal Register - Rules and Regulations - Non-discrimination on the basis of Disability by Public Accommodations and in Commercial Facilities.
3. ASME/ANSI A17.1 – 2004 with 2005 amendments - Elevator Code.
4. Local and State Building Codes.
5. Florida Building Code: Latest adopted edition.
6. Florida Administrative Code. All applicable chapters including but not limited to:
7. Florida Administrative Code 6A-2/SREF (Schools)
8. Florida Administrative Code 10A-12 (Florida Handicap Code - Hospice)

C. Florida Fire Prevention Code

D. Florida Department of Insurance:
1. Insurance Code: The fire alarm system and installation thereof shall comply with the State of Florida Department of Insurance rules. The requirements of the Florida State Department of Insurance shall be as promulgated by the Division of State Fire Marshal.
2. Fire Alarm Rules: The fire alarm system and installation thereof shall comply with the Fire Safety Rules promulgated by the Florida State Fire Marshal.

E. Authority Having Jurisdiction:
1. General: The system shall comply with all applicable Codes, Ordinances and Standards as interpreted and enforced by the local authority having jurisdiction.
2. Fire Department: Orange County Fire/Rescue
3. Building Official: BROWARD COLLEGE BCCO.
4. State of Florida: Division of State Fire Marshal.

1.4 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Magnetic door holders.

7. Remote annunciator.
8. Addressable interface device.

B. The intent of the contract documents is to maintain the existing Fire alarm and Detection system throughout construction. This will include a tie of the old system to the new system. Drawings have been provided to assist with coordinating this effort, but do not necessarily represent the entire scope of the work. Phasing may be modified and altered by contractor with the Owners approval and all such sequencing may require additional temporary connection, conduit, wiring and equipment. The contractor shall include in the bid all cost to maintain the existing and new system functioning harmoniously.

C. The work described herein and on the drawings consists of all labor, materials, equipment, and services necessary and required to provide and test automatic fire detection and alarm system. Any material not specifically mentioned in this specification or not shown on the drawings but required for proper performance and operation shall be provided.

D. Drawings and specifications herein comply to the best of the engineer's knowledge with all applicable codes at the time of design. Coordinate/verify (prior to bid) the requirements of the authority having jurisdiction over this project and bring any discrepancies to the engineer's attention at least seven (7) days prior to bid. No changes in contract cost will be acceptable, after the bid, for work and/or equipment required to comply with the authority having jurisdiction.

E. Circuit routing for this system is not necessarily shown on the project drawings. Provide raceways, wiring and cabling required for a complete and fully functional system as intended by these specifications in accordance with division 26 requirements. Provide a properly sized, flush mounted outlet box for every device. Size and route raceways to accommodate the proper installation of the system cabling. T-Tapped cabling shall not be acceptable. In locations where raceway and/or conduit is not accessible after completion of the project, conduit shall be routed from device to device or fire rated access panels shall be installed to provide access to junction and pull boxes. Routing of raceway from device to device shall only be acceptable where the wiring scheme of the system, as recommended by the manufacturer, requires cable to pass from device to device. Properly terminate each device according to the manufacturer’s recommendations.

F. Conduit will provide a pathway for all cables concealed within walls, run in exposed ceiling spaces, run in inaccessible ceiling spaces (Drop ceilings above 11’ in height are also considered inaccessible), run exterior of the building, or subject to physical damage.

G. This Specification describes a fully addressable, common fire alarm system, with remote fire alarm control units and power supplies for various buildings and portables.

H. Provide and install the Fire Alarm system (including all equipment, wiring, etc.) in accordance with the Manufacturer’s recommendations.

1. Installation of devices shall be in accordance with the Manufacturer’s requirements as well as the requirements of the Contract Documents.

Recommendations by the Manufacturer for the proper installation of the Fire Alarm system and its equipment shall not preclude the requirement to comply with the requirements of the Contract Documents.

2. Termination of Fire Alarm circuits shall be in accordance with the Manufacturer's recommendations, applicable requirements of the National Electric Code (NFPA 70), National Fire Alarm Code (NFPA 72), ADA, other applicable Codes and the Contract Documents.
3. Voice evacuation audio circuits (25 or 70V) shall be run in separate raceways from Fire Alarm data loops and other system circuits where the potential exists for interference or adverse effect upon the proper operation of the any Fire Alarm equipment, circuit or the system as a whole.
4. Ensure that prior to bidding the project the raceway requirements for the project. Claims after award of the project in regard to additional raceway required either by the Fire Alarm System Manufacturer's recommendations for proper installation of the system and its associated equipment, or for compliance with the requirements of the Contract Documents, shall not be allowed.
5. Note that the drawings show Fire Alarm Control Units (FACU) in various locations. FACU's are intended to be equipment (remote control panels, power supplies, addressable modules, power, grounding, and any other equipment or materials) necessary for a remote extension of the Fire Alarm System. FACU's shall be connected to the campus main FACU via fiber optic interface specifically recommended by the Fire Alarm manufacturer and required to meet the intent of the project documents. An individual FACU shall provide the necessary circuitry (Notification Appliance Circuits (NAC), Signal Line Circuits (SLC), DC power circuits required by various devices, etc.) to the Fire Alarm devices within its coverage area. The FACU shall provide interconnection services between the device circuits in its area of coverage and the FACU just as if those device circuits were directly connected to the main FACU. All FACU's will be connected to the main FACU via a fiber connection only.

1.5 DEFINITIONS

A. LED: Light-emitting diode.

B. NICET: National Institute for Certification in Engineering Technologies.

C. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.6 SYSTEM DESCRIPTION

A. Noncoded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only. The system shall include but not be limited to:

1. Main Fire Alarm Control Unit (FACU) including all required power supplies
2. Fire Alarm Annunciator Panel (FAAP)
3. Analog Dialer for temporary operation until data link is available
4. Manual Pull Stations
5. Smoke Detectors

6. Duct Detectors
7. Heat Detectors
8. Combination Audible/Visual devices (indoor and outdoor weatherproof as indicated on the drawings)
9. Visual devices (indoor and outdoor weatherproof as indicated on the drawings)
10. Remote fire alarm control units (Network Nodes)
11. Remote power supplies (Remote power supplies shall be in a UL Listed assembly and be provided by the same manufacturer as the Fire Alarm Control Panel (FACU)).
12. U.L. Listed Communicator, DMP: XR-500.
13. Surge Suppression
14. Programming.
15. Grounding
16. Wire and cable labeling.
17. Electrical power required to comply with all functions and operations called for in this section of the specifications. Provide all 120 VAC circuits as required.
18. Conduit, wire, wire fittings, terminal cabinets with plywood and terminal strips, and all accessories required to provide a complete operating system.
19. A complete and accurate schematic/drawing of the fire alarm system to be placed adjacent to the fire alarm annunciator panel and the main fire alarm panel.

B. Provide all equipment (raceways, wire/cable, circuit breakers, modules, relays, etc.) necessary, and as required by applicable code, to accomplish incidental functions of the fire alarm system including but not limited to the following:

1. Elevator recall, control, and/or shutdown.
2. Monitoring of Sprinkler System and/or Fire Protection System Flow and Tamper switches.
3. Monitoring of Sprinkler System and/or Fire Protection System Valve Supervisory switches.
4. Monitoring of Post Indicator Valve (PIV) switches.
5. Gas/Fuel valve shutoff.
6. HVAC system control and/or shutdown.
7. Ventilation system (supply fans, exhaust fans, fan terminal boxes, etc.) control and/or shutdown.
8. Control of fire, smoke, and/or combination fire/smoke dampers.
9. Fire suppression and or extinguishing systems.
10. Monitoring of kitchen hood fire suppression systems
11. Control of fire and/or smoke doors, dampers, shutters, etc.
12. Control of door hold open devices.
13. Connection to UL Listed communicator via data drop.

C. Fire alarm system shall not share a raceway, junction box, enclosure, manhole or device with any other system.

D. Provide terminal cabinets sized to house terminal strips and surge suppression equipment.

E. Surge Suppression

1. Provide equipment on the AC voltage supply and other lines taking care to arrest damaging electrical transient and spikes which can cause damage to the microprocessor components of the system. Central office telephone lines shall have equipment installed to arrest high voltages from electrical and/or lightning from entering the system and causing damage.
2. Provide and install all materials, labor and auxiliaries required to furnish and install complete surge suppression for the protection of building fire alarm system from the effects of induced transient voltage surge and lightning discharge as indicated on drawings or specified in this section.
3. Provide surge suppression equipment at the following locations:
    a. On each conductor pair and cable sheath entering or leaving a building.
    b. On each conductor associated with fire protection (sprinkler) system fire alarm connections.
    c. On any and all telephone lines.
    d. In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to the design of the equipment. Where equipment being protected has internal surge suppression equipment, the surge protection equipment herein specified is required to be installed in addition to internal equipment protection.

1.7 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72.

B. Fire alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Verified automatic alarm operation of smoke detectors.
5. Automatic sprinkler system water flow.
6. Hood fire suppression system
7. Fire extinguishing system operation.
8. Fire standpipe system.

C. Fire alarm signal shall initiate the following actions:

1. Alarm notification appliances shall operate continuously.
2. Identify alarm at fire alarm control units and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Release fire and smoke doors held open by magnetic door holders.
5. Activate voice/alarm communication system.
6. Elevator recall (primary and secondary)
7. Activate emergency lighting control.
8. Release smoke vents (only if stage detectors are activated)
9. Gas valve shut off
10. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
11. Close smoke dampers in air ducts of system serving zone where alarm was initiated.

12. Record events in the system memory.
13. Record events by the system printer.

D. Supervisory signal initiation shall be by one or more of the following devices or actions:

1. Operation of a fire-protection system valve tamper.
2. Fire-pump power failure, including a dead-phase or phase-reversal condition.
3. Fire pump alarm
4. Elevator shunt trip power monitor
5. Duct Detectors

E. System trouble signal initiation shall be by one or more of the following devices or actions:

1. Open circuits, shorts and grounds of wiring for signaling line and notification-appliance circuits.
2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire alarm control unit.
4. Ground or a single break in fire alarm control unit internal circuits.
5. Abnormal ac voltage at fire alarm control unit.
6. A break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire alarm control unit or annunciator.
9. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

F. Under fire drill, the following actions shall occur:

1. Only the notification appliances and door release shall operate under fire drill condition.

G. System Trouble and Supervisory Signal Actions:

1. Annunciate at fire alarm control unit and remote annunciators.
2. Record the event on system printer.
3. Transmit signal to the remote receiving station

H. ZONING

1. Initiation Zones.
   a. Regardless of the number of zones shown on drawings, the minimum alarm zones required are:
      1) One per building, per floor for pull stations.
      2) One per building, per floor for automatic devices.
      3) One for each duct smoke detector).
      4) Each device shall be individually annunciated/addressable.

2. Notification Zones.
   a. Regardless of the number of zones shown on drawings the minimum notification zones (horns and strobe lights) required are:
      1) One (or more) circuit(s) for administration building

2) One (or more) circuit(s) for exterior horns
3) One (or more) circuit(s) for remainder of campus.

3. Breakdown circuits as required for load and distances involved.

1.8 SUBMITTALS

A. 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.
c. Licensed or certified by authorities having jurisdiction.

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

C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Include voltage drop calculations for notification appliance circuits.
3. Include battery-size calculations.
4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
6. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

D. Delegated-Design Submittal: For smoke and heat detectors indicated to comply 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 smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.

E. Qualification Data: For qualified Installer.

F. Field quality-control reports.

G. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

    a. Frequency of testing of installed components.
    b. Frequency of inspection of installed components.
    c. Requirements and recommendations related to results of maintenance.
    d. Manufacturer's user training manuals.

5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.
7. Copy of NFPA 25.

H. 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.

1.9 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installation shall be by personnel certified by NICET as fire-alarm Level III technician.Company specializing in installing the products specified in this section with minimum ten (10) years experience.
2. The Installer shall be currently licensed by the Electrical Contractors’ Licensing Board as a Certified Alarm System Contractor I (EF).
3. The installing Contractor shall be a direct sales division of, or the authorized and designated distributor for, a fire alarm system manufacturer.
4. Installing Contractor shall maintain a local staff of specialists, including a Fire Alarm Planning Superintendent, for planning, installation, and service.
5. The installing Contractor shall maintain an office within fifty (50) miles of the project with capability to provide emergency service 7-days-a-week, 24 hour days. The installing Contractor shall have been actively engaged in the business

of selling, installing and servicing fire alarm systems for at least ten (10) consecutive years going back from date of bid.

B. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

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.

D. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.

1.10 PROJECT CONDITIONS

A. 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 Construction Manager and Owner no fewer than two days in advance of proposed interruption of fire alarm service.
2. Do not proceed with interruption of fire alarm service without Construction Manager' and Owner's written permission.

1.11 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.

C. Provide any required temporary connections to keep all areas not under construction functional and tied to the campus fire alarm system. This includes all panels and devices.

1.12 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for One year.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within one year from date of

Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.13 ADDITIONAL DEVICES FOR JURISDICTIONAL COMPLIANCE

A. Prior to bid, review plans and specifications carefully for compliance with all codes and in particular, the ADA Requirements and NFPA 72. Include in bid price any devices required to provide a fully compliant system. Said additional devices shall be shown on shop drawings submitted by contractor.

B. In addition to the above-mentioned devices, include in bid price the cost of installing twenty additional audible/visual notification devices (over and above those shown on drawings, required by specifications, or determined by system installed to be required) whose location/need may not become apparent until just prior substantial completion date. At least two weeks prior to substantial completion; system shall be fully operational. After system is operational BROWARD COLLEGE Safety Representative and the system installer shall review the placement of and coverage provided by visual and audible signals throughout the facility for compliance with all codes and in particular, the ADA Requirements and NFPA 72. Provide the additional devices at locations where the Architect/Engineer requests for complete coverage. The additional devices shall be installed and fully operational prior to date of Substantial Completion.

C. After the project has had its first annual safety inspection the system installer shall install within one weeks notice any additional audible/visual signals that have been determined to be required during said inspection from the balance of the (20) twenty additional devices noted above. There shall be at no costs for these added devices provided the total does not exceed the balance remaining of the (20) twenty devices noted above. The final balance of the twenty additional devices included in bid price shall be turned over to the owner as spare material after any fire alarm issues identified during the first annual safety inspection are resolved.

1.14 MAINTENANCE SERVICE

A. Furnish service and maintenance of fire alarm system for one (1) year from date of Substantial Completion.

1. No charge shall be made for any labor, equipment, or transportation during this period to maintain functions.
2. Respond to trouble call within twenty-four (24) hours after receipt of such call.

B. Provide annual testing and inspection of fire alarm system at end of first year in accordance with NFPA 72. Correct any deficiencies found at no cost to the Owner. Affix fire alarm tag to panel.

1.15 WARRANTY

A. Warrant the equipment to be new and free from defects in material and workmanship. Within one year from date of acceptance by owner, repair or replace any equipment found to be defective.

1. No charges shall be made for any labor, equipment, or transportation during this period to maintain functions.
2. Respond to trouble call within twenty-four (24) hours after receipt of such a call.

B. Guarantee all wiring and raceways to be free from inherent mechanical or electrical defects for one (1) year from date of final acceptance of the system.

C. Surge Suppression

1. All surge suppression devices shall be warranted to be free from defects in materials and workmanship for a period of five (5) years.
2. Any suppressor which shows evidence of failure or incorrect operation during the warranty period shall be repaired or replaced by the manufacturer and installer at no cost to the owner.
3. Equipment that is damaged by surges during warrantee period shall be replaced at no expense to Owner.

1.16 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Smoke Detectors: Three (3) of each type installed.
2. Keys and Tools: Three (3) sets for access to locked and tamperproofed components.
3. Surge Suppression devices: Three (3) of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. United Technologies EST.
2. Notifier by Honeywell
3. Fire Control Instruments (FCI)
4. Silent Knight Farenhyt IFP Series

2.2 RACEWAYS

A. General:

1. All raceways (conduits, wireways, pullboxes, outlet boxes, etc.) shall comply with applicable requirements of sections within Division 26 of these specifications.
2. All raceways (conduits, wireways, pull boxes, outlet boxes, etc.) shall comply with all requirements of the manufacturer of the fire alarm system.

B. Conduit: Comply with Section 26 05 33 except as noted below:

1. Pull Cords: Install pull cords in all raceway runs that are installed without cable.
2. Size: Minimum size shall be 3/4" conduit.

C. Boxes:

1. All outlet boxes, junction boxes, pull boxes, etc. shall comply with applicable section of these specifications.
2. Boxes shall be sized as required by the fire alarm system manufacturer and NEC for cables and/or device installed.

2.3 TERMINATION CABINETS

A. Terminal cabinets shall be N1 24” x 20”x 6” hinged cover minimum. See division 26 for additional requirements.

2.4 MAIN FIRE-ALARM CONTROL UNIT

A. General Requirements for main Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.

    a. 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.
    b. Include a real-time clock for time annotation of events on the event recorder and printer.
    c. Master controller shall store all programming in non-volatile memory.
    d. Master controller shall have an event log capable of storing a minimum of two hundred fifty-five (255) events in non-volatile memory.
    e. Listed for use with smoke control systems.

2. Addressable initiation devices that communicate device identity and status.

    a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
    b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.

4. Control panel shall provide provisions for future expansion.

B. System Capability

1. Communication with addressable devices: The system must provide communication with all initiating and control devices individually. All of these devices are to be individually annunciated at the control panel. Annunciation shall include "Alarm", "Trouble", "Open", "Short", "Ground", "Device Fail" or "Incorrect Device" conditions for each point.
2. All addressable devices are to have the capability of being disabled or enabled individually.
3. Each Signal Line Circuit (SLC) two-wire loop shall be capable of addressing a minimum of ninety-nine (99) addressable devices and ninety-eight (98) monitor or control modules.
4. Identification of Addressable Devices: Each addressable device must be uniquely identified by an address code entered on each device at time of installation. The use of jumpers to set address will not be acceptable due to the potential of vibration and poor contact.
5. Wiring Type, Distances, Survivability and Configurations: The system must allow up to 2,500 feet wire length to the furthest addressable device. Style 4 Signaling Line Circuit (as defined by NFPA-72) communications will be provided.
6. System shall be capable of addressable devices and conventional devices within the same system.
7. All system circuits shall be inherently power limited per NEC 760.
8. System shall be capable of communication with a minimum of fifteen (15) remote fire alarm control unit locations via fiber optic network interface.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm 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: Liquid-crystal type, 3 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. Circuits:

1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.

    a. Notification Appliance Circuits: Style Y.
    b. Signaling Line Circuits: Style 4.
    c. Install no more than 75 addressable devices on each signaling line circuit.

2. Serial Interfaces: Two RS-232 ports for printers.

E. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

F. Elevator Recall:

1. Smoke detectors at the following locations shall initiate automatic elevator recall. Alarm-initiating devices, except those listed, shall not start elevator recall.

    a. Elevator lobby detectors except the lobby detector on the designated floor.
    b. Smoke detector in elevator machine room.

2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
3. Heat detector or water flow devices connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.

    a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

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: The main FACU shall automatically transmit alarm, supervisory, and trouble signals to alert fire department and/or Owner’s remote monitoring service.

J. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.

1. Indicated 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 and be listed by an NRTL.

a. Allow the application of and evacuation signal to indicated number of zones and, at 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 unit.

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. Modem

1. A modem shall be provided as an integral part of the main fire alarm control unit (FACU). The modem shall provide the Owner with the ability to accomplish the following functions:

a. View device sensitivity information.
b. View system activity in real time.
c. Access and view the system history log.
2. Modem shall not allow changes to system programming.
3. Modem shall operate at a minimum speed of 9600 baud.
4. Modem shall provide an RJ-11 connector for connection to a telephone line.
5. Coordinate with the Premise Distribution System (PDS) for interconnection to a telephone line.
6. The modem shall mount inside the main fire alarm control unit (FACU)

L. 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 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.

M. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium.

N. 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 FIRE ALARM CONTROL UNIT

A. Fire alarm control units will have all of the capabilities of the main fire alarm control unit except for the following functions.

1. Transmission to Remote Alarm Receiving Station
2. Print out of events
3. Modem

2.6 MANUAL FIRE-ALARM BOXES

A. 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. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Upon actuation, they shall not be restorable to normal except by use of a key. The key shall also allow stations to be tested nondestructively.
3. The stations shall be constructed of metal, with operating directions provided on the cover in highlighted, embossed lettering. The words "FIRE ALARM" shall appear on the door in embossed letters one-half inch high or larger. Mount at 48" above finished floor to top and in accordance with NFPA and handicap standards.

2.7 SYSTEM SMOKE DETECTORS

A. 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 unit.
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.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
   a. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. Field adjustment of the sensitivity shall be possible when conditions require a change.
3. An operator at fire-alarm control unit, 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.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, 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.
4. Detector shall provide detection of combustion gases and smoke in air conditioning ducts in compliance with NFPA 90A. Detector shall be UL-listed specifically for the use in air handling systems.
5. Each sensor shall have multiple levels of detection sensitivity.
6. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
7. Whether shown on drawings or not, a remote alarm indicator/test station shall be provided for each duct mounted smoke detector to annunciate smoke detector operation remotely. Mount unit in ceiling or wall near respective remote smoke detectors (in an occupied space).
8. Provide duct mounted smoke detectors in both the supply and return air ducts of air handlers and “cross zone” so that either single detector will only initiate a “trouble/supervisory” alarm and shut down the air handler. Duct detectors are not to sound a general alarm.

2.8 HEAT DETECTORS

A. General Requirements for Heat Detectors: Analog addressable heat detectors that comply with UL 521, as called for on drawings. Combination detector head and twist-lock base shall be UL-listed compatible with a UL-listed fire alarm panel.

B. Heat detector shall have a flashing, status-indicating LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady and at full brilliance. Detector may be reset by actuating the control panel reset switch.

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 unit.

D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 135 deg F (57 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 unit.
3. Provide 190 deg F (88 deg C) in rooms with high heat sources such as the Kiln room.
4. Detectors shall have a smooth ceiling rating of 900 square feet.
5. Where indicated on the drawings, provide heat detectors rated, by the manufacturer, as explosion proof. If not an integral part of the heat detector assembly, the addressable module shall be located outside the area protected by the explosion proof heat detector (but interior to the building) in an accessible area.

2.9 NOTIFICATION APPLIANCES

A. AUDIBLE NOTIFICATION DEVICES

1. Audible notification devices shall be wall mounted at each location designated on the drawings and/or as specified herein.
2. The audible notification device shall include screw terminals for in-out field wiring. The device shall surface mount to a standard 4" sq. x 2 -1/8" backbox.
3. The audible notification devices shall be U.L. listed for fire protective service and shall provide 24 VDC inputs and sound output of not less than 75 dBA at 10 feet, or more than 120 dBA at the minimum hearing distance from the audible appliance.

    a. Audible notification device shall compliant with ANSI S3.41 for signal character conformance.
4. Audible notification devices located on the exterior of a building, or in a damp or wet location, shall be a weatherproof version and rated, by the manufacturer, for use in wet locations.

B. AUDIBLE/VISUAL NOTIFICATION DEVICES

1. Audible/visual notification devices shall be wall mounted at each location designated on the drawings and/or as specified herein.

2. Audible/visual notification device shall include screw terminals for in-out field wiring. The device shall surface mount to a standard 4" sq. x 2 -1/8" backbox.
3. Audible portion of the audible/visual notification devices shall be U.L. listed for fire protective service and shall provide 24 VDC inputs and sound output of not less than 75 dBA at 10 feet, or more than 120 dBA at the minimum hearing distance from the audible appliance.

    a. Audible portion of the audible/visual notification device shall compliant with ANSI S3.41 for signal character conformance.
4. Audible portion of audible/visual notification devices located on the exterior of a building, or in a damp or wet location, shall be a weatherproof version and rated, by the manufacturer, for use in wet locations.
5. Visual portion of the audible/visual notification devices shall comply with the Americans with Disabilities Act which includes the following:

    a. Lamp shall be a xenon strobe type or equivalent.
    b. Visual indicating portion of the device shall be at the bottom of the device.
    c. Color shall be clear or nominal white (i.e. unfiltered or clear filtered white light).
    d. Maximum pulse duration shall be two-tenths of one second (0.2 sec) with a maximum duty cycle of 40 percent. Pulse duration is defined as the time interval between initial and final points of 10 percent of maximum signal.
    e. Intensity shall be a minimum of 75 candela. Use of visual devices rated at 15/75, 15 or 30 candela shall not be acceptable.
    f. Flash rate shall be a minimum of 1 Hz and a maximum of 3 Hz.
    g. More than two visible notification appliances in the same room or adjacent space within the field of view must flash in synchronization. This requirement shall not preclude synchronization of appliances that are not within the same field of view.
6. A suitable polycarbonate cover shall be provided to protect devices at locations where they may be subject to damage such as Gymnasiums.

C. VOICE/TONE SPEAKERS:

1. Comply with UL 1480, "Speakers for Fire Protective Signaling."
2. Speakers: Compression-driver type with flared projectors having a frequency response of 400 to 4000 Hz; equipped with a multiple tap, varnish-impregnated, sealed, matching transformer. Match transformer tap range and speaker power rating to the acoustical environment of the speaker location.
3. High-Range Speaker Units: Rated 2-15 watts.
4. Low-Range Speaker Units: Rated .25-2 watts.
5. Speaker Mounting: Recessed.
6. Combination speaker/strobe appliances shall be provided for all wall mounted devices. Ceiling units shall be fully recessed and speaker only. Ceiling speaker shall be white round perforated. Wall units shall be red square perforated.

D. VISUAL NOTIFICATION DEVICES

1. Visual notification devices shall be wall mounted at each location designated on the drawings and/or as specified herein. Visual notification devices shall be of the flashing type in compliance with Americans with Disabilities Act.

2. Visual notification devices shall comply with the Americans with Disabilities Act which includes the following:

    a. Lamp shall be a xenon strobe type or equivalent.
    b. Visual indicating portion of the device shall be at the bottom of the device.
    c. Color shall be clear or nominal white (i.e. unfiltered or clear filtered white light).
    d. Maximum pulse duration shall be two-tenths of one second (0.2 sec) with a maximum duty cycle of 40 percent. Pulse duration is defined as the time interval between initial and final points of 10 percent of maximum signal.
    e. Intensity shall be a minimum of 75 candela. The use of visual devices rated at 15/75, 15 or 30 candela shall not be acceptable.
    f. Flash rate shall be a minimum of 1 Hz and a maximum of 3 Hz.
    g. Fire alarm system strobes within same room shall flash in synchronization as required by NFPA.
    h. More than two visible notification appliances in the same room or adjacent space within the field of view must flash in synchronization. This requirement shall not preclude synchronization of appliances that are not within the same field of view.
3. A suitable polycarbonate cover shall be provided to protect devices at locations where they may be subject to damage such as Gymnasiums.

2.10 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

    1. Electromagnet: Requires 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.

B. Material and Finish: Match door hardware.

2.11 REMOTE ANNUNCIATOR (FAAP)

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

    1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals. Provide button for fire drill.

2.12 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to elevator controller to initiate AHU shutdown, elevator recall, to circuit-breaker shunt trip for power shutdown, smoke door operation, smoke damper operation, audio system mute function, or other required functions.

2.13 PULL STATION SECURITY COVER

A. Provide where pull station devices are required to be protected as indicated on the drawings.

B. Shall be UL Listed.

C. Constructed of clear polycarbonate.

D. Provide with battery operated warning horn.

E. For flush or surface mount devices.

F. Provide with weather gasket.

G. Spacers for additional depth as required.

H. Provide with tamper proof screws.

I. Design criteria:

1. Safety Technology International, Inc. #1100 Series.

2.14 NETWORK COMMUNICATOR

A. Provide DMP XR500 network communicator to communicate with Owners proprietary receiving station.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically transmit the signal via the premise distribution system to the Owners remote central station. When contact is made with central station(s), signals shall be transmitted.

C. Local functions and display at the network communicator transmitter shall include the following:
1. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply or loss of power.
5. Low battery.
6. Abnormal test signal.
7. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

2.15 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of device.
2. Finish: Paint of color to match the protected device.

2.16 SURGE SUPPRESSION

A. Non-Addressable Initiation Devices:

1. Plug-in replacement modular design with associated female wiring connector.
2. U.L. 497B listed and labeled.
3. Multi-stage hybrid protection circuit.
4. Fail short/fail safe.
5. Surge Capacity: 10KA with 8 x 20 μs waveform, 500A per line with 10 x 700 μs waveform.
6. Clamp Voltage: 150% of circuit peak operating voltage with 100 amp 10 x 700 μs waveform.
7. Maximum Continuous Operating Voltage: 125% of peak operating voltage, minimum.
8. Capacitance: 1500 pf.

B. Addressable Initiation Devices and Data Loops:

1. Plug-in replacement modular design with associated female wiring connector.
2. U.L. 497B listed and labeled.
3. Multi-stage hybrid protection circuit.
4. Fail short/fail safe.
5. Surge Capacity: 10KA with 8 x 20 μs waveform, 500A per line with 10 x 700 μs waveform.
6. Clamp Voltage: 150% of circuit peak operating voltage with 100 amp 10 x 700 μs waveform.
7. Maximum Continuous Operating Voltage: 125% of peak operating voltage, minimum.
8. Capacitance: 50 pf.

C. Horn, Strobe, Control Power (Low Voltage):

1. Plug-in replacement modular design with associated female wiring connector.
2. U.L. 497B listed and labeled.
3. Multi-stage hybrid protection circuit.
4. Fail short/fail safe.
5. Surge Capacity: 5KA with 8 x 20 μs waveform.
6. Clamp Voltage: 150% of circuit peak operating voltage with 100 amp 10 x 700 μs waveform.
7. Maximum Continuous Operating Voltage: 125% of peak operating voltage, minimum.
8. Series Resistance: 0.2 ohms total per pair.

D. Power Circuit (120 volt):

1. U.L. 1449 listed.
2. 15 amp, 120V rated.
3. Suppressors shall be tested per IEEE, C62.41-1991 for Categories A and B.
4. Normal mode (L-N), and common mode (L+N-G) protection.
5. Internal fusing.
6. Hybrid design.
7. Indicators for normal operation and failure indication.
8. Enclosure:
   a. Fire retardant high impact, phenolic or plastic housing or metal enclosure.
9. Clamping voltage U.L. 1449, Line to Neutral, Category B Impulse At (3KA, 8 x 20 μs): 385V @ 120V.
10. Maximum Surge Capacity: 20,000 amps.
11. Maximum Continuous Operating Voltage: 115% of line voltage.
12. Provide hardwire connection or add 15 amp receptacle device to hardwired devices to match equipment being protected and maintain U.L. listing.
13. Provide additional 15 amp in-line fusing as required to comply with U.L. and the N.E.C. when connected to a 20 amp, 120V circuit.

2.17 CABLE

A. Conductor: 98% conductivity, stranded copper with maximum of 7 strands. Stranded conductors shall have a compression lug installed at every end. Wrapping twisted strands at terminal block screw is not acceptable. As an acceptable equivalent, stranded conductors without crimp-on lugs may be terminated into terminal strips of box-lug connectors. Solid copper is not acceptable.

B. Insulation: A type accepted by NEC for the application. All cable shall be UL listed for fire-protective signaling application. Communication, Class 3 or Multi-Purpose cables shall not be substituted for FP cable types.

C. Size: All conductors shall be sized as prescribed by the system manufacturer, with following minimums:
1. Multiplex Signaling Line Circuit: AWG #14, shielded twisted pair.
2. Notification Circuits, Devices: AWG #14.
3. Initiating Circuits, Hard-Wired Devices: AWG #14.

4. Initiating Circuits, Addressable Devices: AWG #14, shielded twisted pair.
5. Provide larger conductors where required to maintain voltage drop or signal strength within acceptable limits. Provide cable as required by the manufacturer, as specified elsewhere in these specifications, and to provide a complete, fully operational, UL Listed Fire Alarm system.

D. Fire alarm system cables installed in interior, exterior and/or underground raceways shall comply with the applicable sections of N.E.C. Articles 760, 770 and 800.

E. Wiring shall be sized to allow a maximum of 8% voltage drop for all notification circuits and 3% for all A/C circuits.

F. Wiring color code shall be as follows:

1.	Horns/Strobes	Black/Red
2.	Door Holders	White
3.	A.H.S.D.	Purple
4.	Gas Shut-Off Pull Stations	Orange
5.	Addressable	Twisted Pair Data Wire
6.	Hard-Wired	Brown/Blue

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Equipment Mounting: Install fire-alarm control unit on finished floor with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

C. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

D. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, 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 Appendix A in NFPA 72.
5. HVAC: Locate detectors not closer than 5 feet (1.5 m) 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.

E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

F. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

G. Audible Alarm-Indicating Devices: Install not less than 90” AFF or 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.

H. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn, visual indicating unit not less than 80 in AFF and not more than 96” AFF.

I. Device Location-Indicating Lights: Locate in public space near the device they monitor. All concealed detectors shall be provided with a remote indicating lamp and test switch installed in an occupied space (corridor, etc.) on wall or on the ceiling grid indicating the type of detector and the zone to which it is connected. Label shall be red with white lettering.

J. Duct detectors shall be installed in accordance with NFPA 90A. All brackets and hardware shall be provided as required to install detector housing in correct position. All detector housings shall be sealed as required to prevent air leakage between duct and housing. Sampling tubes of proper length shall be provided and installed to match duct width at the installed location.

K. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

L. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

M. Provide all work required for a complete system including complete system testing and checkout. All components shall be properly mounted and wired. The installation of this system shall comply with the directions and recommendations of authorized factory representatives.

N. Provide wiring, cabling, raceways, and electrical boxes in accordance with manufacturer's written instructions.

O. Components shall be electrically "burned-in" by operating the component at full power for a period as recommended by the manufacturer.

P. Installation shall be done in a neat workmanlike fashion by a firm regularly engaged in Fire Alarm Installation and Service.

Q. The installation and inspection of all fire detection and fire alarm devices and systems shall be performed by, or under the direct on-site supervision of, a licensed fire alarm technician or a fire alarm planning superintendent who shall certify the work upon completion of the activity. The certifying licensee shall be present for the final test prior to certification.

R. As-built plans and wiring diagrams shall bear the signature and license number of the licensed fire alarm planning superintendent, the date of installation and the name, address, and certificate-of-registration number of the registered firm.

S. All components shall be completely wired. System shall be fully operable when main power service has failed and the Emergency Standby Generator has assumed emergency system loads. This shall require that any devices which required 120 volt power shall receive supply from an emergency 120 volt source.

T. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet (1 m) 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 firefighter smoke-control system panel.
2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
3. Smoke dampers in air ducts of designated air-conditioning duct systems.
4. Alarm-initiating connection to elevator recall system and components.
5. Alarm-initiating connection to activate emergency lighting control.
6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
7. Supervisory connections at valve supervisory switches.
8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
9. Supervisory connections at elevator shunt trip breaker.
10. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
11. Supervisory connections at fire-pump engine control panel.

U. Apply a compression lug, similar to T&B Sta-Kon Terminal, to all stranded conductors at terminations or use box-lug terminal strips.

V. There shall be no wire splices. All wiring shall be continuous, uncut between devices and terminal blocks.

3.2 MANUAL PULL STATIONS

A. Install at 48 inches to top above finished floor.

B. All manual stations shall be in unobstructed locations.

C. Install to comply with NFPA, ADA, and all handicap/accessibility code requirements.

D. Provide, install, and connect additional pull stations (from that shown on drawings) as required to comply with above requirements.

3.3 AUDIBLE SIGNAL DEVICES, VISUAL SIGNAL DEVICES OR COMBINATION AUDIBLE/VISUAL SIGNAL DEVICES

A. Shall comply with NFPA, the Americans with Disabilities Act and other applicable handicap/accessibility codes including but not limited to the following:

1. Wall mounted devices shall have their bottom edge of the visual indicating portion of the device mounted at 80 inches AFF.
2. In general, no place in any room or space required to have a visual signal appliance shall be more then 50 ft. (15 m) from the signal (in the horizontal plane).
3. No place in common corridors or hallways in which visual alarm signaling appliances are required shall be more than 50 ft. (15 m) from the signal. Placement of visual devices shall not be less than the requirements as specified by NFPA 72.

3.4 END-OF-LINE DEVICE

A. Mount end-of-line device box with last device or separate box adjacent to last device in circuit.

3.5 AUXILIARY CONTROL RELAYS

A. An auxiliary fire alarm relay used to control an emergency control device, e.g. motor controller for HVAC system fan or elevator controller shall be located within 3 ft. of the emergency control device.

B. The installation wiring between the system panel and the auxiliary fire alarm relay shall be monitored for integrity.

C. Auxiliary control relays shall be listed for use with fire alarm systems.

3.6 SPRINKLER FLOW SWITCHES

A. Coordinate the electrical and operating characteristics of the flow switches with the fire alarm panel.

B. Run conduit and wiring to the flow switches, and connect them so as to provide an operable supervised sprinkler alarm system per NFPA standards, and state and local codes.

C. Provide all electrical including zones as required by authority having jurisdiction and codes.

3.7 SPRINKLER VALVE SUPERVISORY SWITCHES

A. Coordinate the electrical and operating characteristics of the supervisory switches with the fire alarm panel.

B. Run conduit and wiring to the supervisory switches, and connect them so as to provide an operable supervised sprinkler alarm system per NFPA standards, and state and local codes.

C. Provide all electrical including zones as required by authority having jurisdiction and codes.

3.8 DOOR ELECTRIC LOCK AND HOLD-OPEN POWER SYSTEMS

A. General: Provide 24V-dc low voltage power to all building doors with openers, hold-open devices, closers or electric locks. Refer to Architectural door hardware schedule for doors that may have electric holders or locks. Low voltage power supplies for door hardware shall be furnished separately from the fire alarm system. The fire alarm system shall only provide the unlocking or release control signals and auxiliary control relays at power supplies, in order to reduce power draw on fire alarm system power supplies and batteries.

B. Low Voltage Power: Provide a low voltage transformer on each floor having doors with electric hardware. Transformer shall be 120-24V ac, sized as required to handle load served. Mount in a NEMA 1 enclosure above accessible corridor ceiling outside the first door closest to fire alarm riser. Provide transformer primary fusing to comply with N.E.C. Provide a 24V ac-24V dc rectifier on the secondary side of the transformer. Provide dedicated branch circuit from closest 120V normal power panel. Provide necessary interposing auxiliary control relay(s) to accept unlocking/release and restore signals from the fire alarm system.

C. Wiring: Electric hardware shall be connected for fail-safe operation. Upon loss of normal power hardware shall unlock without unlatching. Hold-open doors shall release for closure. Restoration of hardware power shall be automatic after the fire alarm system unlock control is reset. Provide all wiring necessary to connect transformer. Provide all low voltage wiring to connect electric locks. Extend wiring down hinge side of stair door jam through hinge plate into door and through door to electric lock mechanism.

D. Fire Alarm Unlocking Control: All door hardware circuits shall be controlled by fire alarm system. Upon receipt of signal from fire alarm system all door holders shall release and stair/egress door electric locks power system shall be disabled allowing all locks to unlock (without unlatching). Signal to activate shall be automatic fire alarm signal or manual command initiated in the building Fire Control Room. Manual unlock override command shall be through override system. Reference paragraph entitled "FIRE DEPARTMENT OVERRIDE CONTROL PANEL". Provide pilot light and 3-position override switch. ON position (illuminated red pilot light) shall initiate fail-safe operation. OFF position shall restore low voltage power. Provide separate override switch for door openers associated with Atrium Smoke Exhaust System.

E. Mount outlet box for electric door holder to withstand 80 pounds (36.4 kg) pulling force.

3.9 GAS/FUEL SHUT-OFFS

A. Whether shown on drawings or not provide gas/fuel shut-off systems for each and every gas/fuel supply as required by the applicable codes and standards.

3.10 ELEVATORS

A. Operation of elevators under fire or other emergency conditions - elevators having a travel distance of 25 feet or more shall conform to the requirements of ANSI A17.1, Safety Code for Elevators and Escalators, as incorporated herein by reference.

B. When an automatic sprinkler system is required to be installed throughout a building for complete fire protection coverage, the provisions of ANSI A17.1, which is incorporated herein buy reference, shall be applicable. An accepted fixed temperature (135 degrees F.) heat detector shall be installed in the elevator machine room to automatically disconnect the main power supply to the affected elevator(s) prior to the application of water. The main power supply shall not be self-resetting. The activation of sprinklers outside of the hoistway or machine room shall not disconnect the main power supply. The sprinkler head located in the elevator machine room shall have an activation temperature greater than the accepted fixed temperature heat detector.

C. Provide detectors with auxiliary relay complete with tie into elevator controller as required by all codes, or provide separate zone.

3.11 CABLE IDENTIFICATION

A. Provide and install permanent cable markers on all cables/wire lines, telephone lines, etc. at terminal strips, terminal cabinets and at main equipment.

3.12 INTERNET CONNECTION

A. Provide a connection from a data outlet (RJ45 connector) mounted adjacent to the FACP to the nearest PDS rack for connection to the internet. Provide and install the DMP: XR-500 panel as required for communication to the BROWARD COLLEGE proprietary supervising station.

3.13 SURGE PROTECTION

A. General

1. Provide, install and connect new surge suppression equipment as specified herein, including protection of equipment power source, cable/wire entering or leaving building housing, main fire alarm system equipment, ground lugs, #6 copper ground wire in 3/4"c. to existing main building service ground.
2. Extreme care shall be taken to assure a properly surge protected system.
3. Surge protection equipment must be selected to match the equipment being protected including wire sizes, operating volts, amps, and circuit impedance.

4. Installation of surge protection equipment and it's grounding must be per manufacturer's recommendations to assure short and proper ground paths.

B. Equipment Selection

1. Coordinate with suppliers and installers of all equipment being protected and provide surge suppression equipment which meets these specifications on respective equipment, wires, etc.

C. Equipment Installation

1. Install surge suppression equipment per manufacturers recommendation at each wire terminal as noted under Part 1.
2. Install in surge suppression equipment terminal cabinets, etc. as required to facilitate installation of surge protection equipment and terminal points. Increase size of terminal cabinets (from that shown on drawings) to size required to facilitate installation of surge suppression equipment and terminal blocks.

D. Ground Installation

1. Ground Bus Connections.
   a. Provide "local" ground bus in each terminal cabinet housing surge protection equipment (with lugs, etc. as required).
   b. Bond "local" ground bus to terminal cabinet with minimum #6 copper wire.
   c. Connect terminal cabinet "local" ground bus to "systems" ground bus with minimum #6 copper insulated wire (unless otherwise noted) in conduit.
   d. Note that "systems" ground bar is also to be used for power transformation ground (480V to 208V) where applicable.
2. Surge suppression equipment grounding.
   a. Connect each surge suppressor to local ground bus in terminal cabinet with wire sized as recommended by manufacturer. Where "M" block type terminations/surge suppressors are used, bond ground rail to local ground bar with wire as recommended by manufacturer.
3. Conductors.
   a. Bends in excess of 90 degrees in any grounding conductor shall not be permitted. A radius of 6 inches or greater shall be maintained on all bends.
   b. Do not bundle unprotected conductors with protected conductors.
   c. Conductors shall be kept as short as possible.
   d. Conductors shall be secured at 12" intervals with an accepted copper clamp.
   e. Grounding conductors shall be properly connected to the building service ground by accepted clamps.
4. Grounding Connectors
   a. Connectors, splicers, and other fittings used to interconnect grounding conductors, bond to equipment or grounding bars, shall be accepted by NEC or U.L. for the purpose.
   b. All connectors and fittings shall be of the Nicopress crimp or compression set screw type.
   c. Special treatment to fittings, lugs, or other connectors of dissimilar material shall be applied to prevent electro-galvanic action.
5. Telephone Circuits

a. Systems utilizing telephone company pairs as a transmission medium shall be provided with a suppressor conforming to device in Part 2 of this specification.
b. Suppressors shall be installed at each point where interface is made to telephone company pairs.
c. In cases where a modem or other device is used to interface with the telephone circuit the following procedure shall apply:
    1) The suppressor shall be installed on the telephone line side of the modem or coupling device.

3.14 CONDUIT/BOX IDENTIFICATION

A. Identify fire alarm conduit and boxes with red paint in exposed locations. Identify conduit in concealed locations with 4" mark of red paint every 4'-0" O.C.

3.15 DEMONSTRATION

A. When system is complete it shall be demonstrated to Owner's Representative who shall be given complete instructions, spare parts, manuals and maintenance information.

3.16 SYSTEM TESTING

A. Prior to certification of the fire alarm system, provide a complete test of the fire alarm system in accordance with NFPA 72, Test Methods.

B. Perform a complete, functional, component by component test of the entire fire alarm and detection system. Provide a detailed step by step testing procedure which is unique to this project, reflecting the type of system and the number and location of all components.

C. Perform a sensitivity test of all smoke detectors and duct detectors. Perform a calibration/test of heat sensors.

D. Demonstrate the proper operation of each component as follows:

1. Photoelectric, and duct smoke detectors: activate the detector with a "false smoke" product which has been specifically formulated for testing smoke detection systems.
2. Heat detectors: activate the detector by utilizing the detector check button.
3. Pull Stations: activate the station by operating the station in its normal mode.
4. Audible and Visual Alarms: verify proper operation when the system is put into the alarm mode.
5. Sprinkler Flow Switches: open the sprinkler system's inspection test valve. Verify that the flow switch sends an alarm signal within the allowed time corresponding to the switch's time delay setting.
6. Fire Alarm Panels: functionally check-out and test the panel per the manufacturer's written instructions. Demonstrate the proper operation of each

modular component. Demonstrate automatic power change to batteries and back to building power upon a drop in voltage below the voltage threshold as specified by the panel manufacturer.

E. Demonstrate the supervisory function at each device loop circuit, and at all single component wiring runs such as for the sprinkler valve supervisory switches.

3.17 CERTIFICATION

A. After completion of the installation of the system, the licensee shall complete a NFPA Inspection and Testing form. The Inspection and Testing form format shall be as indicated in NFPA 72, Inspection and Testing Form. When an Inspection and Testing form has been completed, legible copies shall be distributed as directed by the Authority Having Jurisdiction.

B. After an installation has been complete, affix a Fire Alarm Tag to the control panel. The Fire Alarm Tag is in addition to the Inspection and Testing form. Protect the Fire Alarm Tag from vandalism by applying pressure sensitive label; do not use a "tie-on" tag. It shall be as required in the Fire Safety Rules.

3.18 OWNER'S INSTRUCTION:

A. Provide instruction to the Owner's designated personnel upon completion of the system installation. Instruction shall include a functional training session on fire alarm control panel operation and instruction on peripheral device operation, including what are normal indications and alarm indications of each type of new/added device. Videotape all training sessions and deliver (4) copies of tapes to Owner (for use in future training).

B. Instruct Owner on the importance of fixing any items not found functional during the testing. They must be made aware of the liability associated with failure to repair the system as expeditiously as possible. Failure to do so may result in the injury or death of numerous people in the unfortunate event of a fire.

3.19 FINAL DRAWINGS

A. As-built drawings shall be given to the Owner’s representative, at time of instruction, in addition to those to be supplied as general requirements of the job.

3.20 AUTHORITY HAVING JURISDICTION

A. The drawings and specifications herein comply to the best of the engineer's knowledge with all applicable codes at time of design. However, coordinate/verify (prior to bid) the requirements of the authority having jurisdiction over this project and bring any discrepancies to the engineer's attention at least 7 days prior to bid. No changes in contract cost will be acceptable after the bid for work/equipment required to comply with the authority having jurisdiction

END OF SECTION 283111