



NEW CASTLE COUNTY VO-TECH SCHOOL DISTRICT

PAUL M. HODGSON
VOCATIONAL TECHNICAL HIGH SCHOOL
2575 Glasgow Avenue, Newark, DE 19702

PROJECT MANUAL

BSA+A PROJECT #22.011

Contract No. NCC2401D

Volume 4
Divisions 26 through 33

BID PACKAGE E – Fieldhouse, Athletic Fields, and Storage Buildings
ISSUED FOR BID

November 04, 2025

ABHA | BSA+A

PROJECT MANUAL

NEW CASTLE COUNTY VO-TECH SCHOOL DISTRICT PAUL M. HODGSON VOCATIONAL-TECHNICAL HIGH SCHOOL

Contract No. NCC2401D

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**ISSUED FOR BID
November 04, 2025**

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The following previously issued Bid Package documentation is included by reference:

- BPB Sitework and Utilities dated 25 May 23
Addendum #1 dated 1 Aug 23
Addendum #2 dated 7 Aug 23
Addendum #3 dated 10 Aug 23
- BPC Foundations and Structures 31 Aug 23
Addendum #1 dated 29 Sept 23
Addendum #2 dated 11 Oct 23
Addendum #3 dated 12 Oct 23
Addendum #4 dated 20 Oct 23
Addendum #5 dated 23 Oct 23
- BPD Building Envelop & Fit-Out dated 5 Dec 23
Addendum #1 dated 28 Dec 23
Addendum #2 dated 12 Jan 24
Addendum #3 dated 19 Jan 24
Addendum #4 dated 24 Jan 24
- BPD.1 Building Envelope & Fit-Out (re-bid) dated 11 March 24
Addendum #1 dated 5 April 24
Addendum #2 dated 11 April 24
- BPD.2 Sitework, Concrete, and Paving Specifications dated 11 Oct 24
BPD.2 Sitework, Concrete, and Paving Drawings dated 18 Oct 24
BPD.2 Sitework, Concrete, and Paving Attachment A dated 11 Oct 24
Addendum #1 dated 17 Jan 25
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NEW CASTLE COUNTY VOCATIONAL –
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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 ALTERNATES

- A. Refer to Division 01 Section 012300, *Alternates* for description of work under this Section affected by Alternates.

1.3 SUMMARY

- A. Section Includes:
 - 1. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Foam Duct Sealant.
 - 5. Grout.
 - 6. Common electrical installation requirements.
- B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all electrical work.
- C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.
- D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with Article "Submittals" specified below. The right is reserved to make reasonable changes in location of equipment, boxes, conduit/wiring, and devices, up to the time of rough-in or fabrication.
- E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.

- F. Coordinate the work under Division 26 with the work of all other construction trades.
- G. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the Contract Documents.
- H. Arrange conduit, wiring, equipment, and other work generally as shown, providing proper clearances and access. Carefully examine all Contract Drawings and fit the work in each location without substantial alteration. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with Article “Submittals” as hereinafter specified. The right is reserved to make reasonable changes in location of equipment, conduit and wiring up to the time of rough-in or fabrication.

1.4 PERMITS AND FEES

- A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.
- B. Permits and fees shall comply with Division 01 Section 010000, *General Requirements*.
- C. Notify Inspection Authorities to schedule inspections of work.
- D. Notify Architect and Engineer in advance of scheduled inspections.
- E. An electrical foreman, superintendent or other supervisor shall be in attendance for all scheduled inspections.

1.5 EXAMINATION OF SITE

- A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for Contractor’s failure to do so.
- B. Examine and verify specific conditions described in individual Specifications sections.
- C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

1.6 INTERPRETATION OF DOCUMENTS

- A. Any discrepancies between Drawings, Specifications, Drawings and Specifications, or within Drawings and Specifications shall be promptly brought to the attention of the Owner during the bidding period. No allowance shall subsequently be made by reason of failure to have brought said discrepancies to the attention of the Owner during the bidding period or of any error on the Bidder's part.
- B. The locations of products shown on Drawings are approximate. Place the devices to eliminate all interference with above-ceiling ducts, piping, etc. Where any doubt exists, the exact location shall be determined by the Owner.
- C. All general trades and existing conditions shall be checked before installing any outlets, power wiring, etc.
- D. Equipment sizes shown on the Drawings are estimated. Before installing any wire or conduit, obtain the exact equipment requirements and install wire, conduit, or other item of the correct size for the equipment actually installed. However, wire and conduit sizes shown on the Drawings shall be taken as a minimum and shall not be reduced without written approval from the Owner.
- E. Where variances occur between the Drawings and Specifications or within either document itself, the item or arrangement of better quality, greater quality, or higher cost shall be included in the Contract Price. The Engineer will decide on the item and manner in which the work shall be installed.
- F. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions, and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed Shop Drawings for approval in accordance with Article "Submittals" as herein after specified. The right is reserved to make reasonable changes in location of equipment, conduit/wiring, and devices, up to the time of rough-in or fabrication.
- G. Work not specifically outlined, but reasonably incidental to the completion of the work, shall be included without additional compensation from the Architect, Engineer, or Owner.
- H. Perform the work in a first-class, substantial and workmanlike manner. Any materials installed which do not present an orderly and neat workmanlike appearance shall be removed and replaced when so directed by the Engineer, at the Contractor's expense.
- I. Contact and coordinate service entrance equipment and layout with local power company prior to ordering or installing any service entrance equipment. Contractor shall furnish and install all incoming raceway and service entrance cables. If the power company plans to install cable and/or conduit, Contractor is responsible for proper coordination of cable, conduit, lug sizes, etc., for proper interface between utility owned/installed equipment and Contractor-installed equipment.

- J. The Owner shall make the application for electrical service and pay for all service charges, as coordinated with the Contractor.
- K. The complete set of Architectural, Civil, Structural, Mechanical, and Electrical Drawings and Specifications apply to this work. The successful Bidder shall familiarize himself with all other related documents.

1.7 MATERIALS AND EQUIPMENT

- A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality. Existing items of equipment are being reconnected under another Division of these Specifications. The Contractor shall be responsible for connecting all utilities as shown on the Drawings, to equipment identified as existing.
- B. The Contractor shall only submit those manufacturers indicated in the Specification. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Alternate manufacturers will not be considered unless the specific item indicates “or as approved equal”. Submit all data necessary to determine suitability of substituted items, for approval.
- C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.
- D. Substitution will not be permitted for specified items of material or equipment where noted.
- E. All items of equipment furnished shall have a service record of at least five (5) years.

1.8 ELECTRICAL WORK UNDER OTHER DIVISIONS

- A. Mechanical Equipment and Systems
 - 1. In general, power wiring and motor starting equipment for mechanical equipment and systems are furnished and installed under Electrical Division 26.
 - 2. Certain mechanical units are furnished from the factory with starters, contactors, transformers, fuses, wiring, etc., required for fans, pumps, etc. When this equipment is supplied from the factory, the Electrical Contractor must supply power circuit(s) to the unit and a disconnecting means. Coordinate with Mechanical Contractor so that one and only one, set of starters, fuses, switches, etc., is pro

vided and installed.

3. In general, control and interlock equipment for HVAC systems (including associated wiring, conduit, transformers, relays, contacts, etc.) is furnished under Division 23. Division 26 shall install and connect all such equipment as necessary.
 4. Controls, wiring, conduit, transformers, etc., for smoke, fire, and motor-operated dampers are provided under Division 23. Division 26 shall install and connect all such equipment.
- B. Architectural Equipment: In general, any electrically operated or controlled equipment furnished under architectural divisions shall be supplied with control wiring, transformers, contacts, etc. Provide power circuits and disconnects to such equipment and install all electrical control equipment related thereto.
- C. Owner Furnished Equipment: In general, Owner furnished equipment is either provided or wired by the equipment supplier. Provide power circuits to such equipment and make final connections to equipment being provided by the Owner.
- D. Carefully review the Contract Documents and coordinate the electrical work under the various Divisions.

1.9 FIRE SAFE MATERIALS

- A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

1.10 REFERENCED STANDARDS, CODES AND SPECIFICATIONS

- A. Specifications, Codes and Standards listed below are included as part of this Specification, latest edition:
1. ADA - Americans with Disabilities Act
 2. ANSI - American National Standards Institute
 3. ASTM - American Society for Testing and Materials
 4. CSA - Canadian Standards Association
 5. DNREC - Delaware Department of Natural Resources and Environmental Control
 6. EPA - Environmental Protection Agency
 7. FM - Factory Mutual
 8. IBC - International Building Code
 9. IEEE - Institute of Electrical and Electronics Engineers

- 10. NEC - National Electrical Code
 - 11. NECA - National Electrical Contractors Association
 - 12. NEMA - National Electrical Manufacturers Association
 - 13. NFPA - National Fire Protection Association
 - 14. OSHA - Occupational Safety and Health Act
 - 15. UL - Underwriters' Laboratories
- B. The application standards of the local electric utility company.
- C. Electrical construction materials shall, where a listing is normal for the particular class of material, be listed in *Electrical Construction Materials List* of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Electrical equipment shall, where a listing is normal for the particular class of equipment, be listed in the *Electrical Appliance and Utilization Equipment List* of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Materials and equipment listed and labeled as "approved for the purpose" by other nationally recognized testing laboratory, inspection agency or approved organization (such as E.T.L. or Factory Mutual) shall be acceptable.

1.11 SUBMITTALS

- A. Product Data: For items specified in Part 2 of this Section.

1.12 SUBMITTALS, REVIEW AND ACCEPTANCE

- A. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Architect/Engineer, to be in best interest of Owner.
- B. After acceptance of Material and Equipment List, submit six (6) copies, or more as required under the General Conditions, of complete descriptive data for all items. Data shall consist of Specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, installation instructions, and any other information necessary to indicate complete compliance with Contract Documents. Edit submittal data specifically for application to this project.
- C. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and any electrical requirements for equipment submitted. Contractor shall be responsible for correctness of all submittals.
- D. Submittals will be reviewed for general compliance with design concept in accordance with Contract Documents, but dimensions, quantities, or other details will not be verified.
- E. Identify submittals, indicating intended application, location and service of submitted

items. Refer to Specification sections or paragraphs and Drawings where applicable. Clearly indicate exact type, model number, style, size and special features of proposed item. Submittals of a general nature will not be acceptable. For substituted items, clearly list on the first page of the submittal all differences between the specified item and the proposed item. The Contractor shall be responsible for corrective action and maintaining the Specification requirements if differences have not been clearly indicated in the submittal.

- F. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable. Call attention, in writing, to deviation from contract requirements.
- G. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted. Use only final or corrected submittals and data prior to fabrication and/or installation.
- H. For any submittal requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold Contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.

1.13 SHOP DRAWINGS

- A. Prepare and submit Shop Drawings for all electrical equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the Contract Drawings, or where the proposed installation differs from that shown on Contract Drawings.
- B. Submit Product Data and Shop Drawings including but not limited to the list below, in addition to provisions of the paragraph above. Identify all shop drawings by the name of the item and system and the applicable Specification paragraph number and Drawing number.
- C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.

Items and Systems

- 1. Analysis and Coordination Study
- 2. Automatic Transfer Switches
- 3. Ballasts
- 4. Basic Electrical Materials
- 5. Cable – 600 Volt
- 6. Circuit Breakers
- 7. Conduit and Surface Raceway
- 8. Contractor and Subcontractor Qualifications
- 9. Controllers and Control Devices
- 10. Engine/Generator
- 11. Equipment Connections

12. Equipment Pads
 13. Firestopping
 14. Ground Conductors, Rods
 15. Identification System
 16. Lamps
 17. Lighting Control Equipment
 18. Light Fixtures
 19. Low Voltage Fuses
 20. Material and Equipment List
 21. Motor Controllers
 22. Occupancy and Vacancy Sensors
 23. Outlet Boxes
 24. Panelboards
 25. Receptacles
 26. Record and Information Booklet
 27. Safety Switches
 28. Schedule of Values
 29. Sleeves, Hangers, Supports
 30. Submittal Schedule
 31. Surge Suppression Devices
 32. Switchboards
 33. Tests and Reports
 34. Transformers
 35. Wiring Devices
 36. Wiring Diagrams
- D. Submittals shall include, but not be limited to, the following information: size, type, functional characteristics, compliance with standards in Division 26, required service access which shall be suitable for intended location and use, electrical service connections and requirements, and deviations from Contract Document requirements.
- E. Submit for approval any other shop drawings as required by the Architect/Engineer. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Engineer.
- F. Submit for approval schematic diagrams of each electrical system installed in the building. Diagrams shall indicate device location, service, type, make, model number and the identification number of each device in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under glass and hung in each Main Equipment Room. Deliver the tracing or sepia from which the diagrams were reproduced to the Owner.
- G. Submittals shall include Riser Diagrams and Schematic Wiring Diagrams, complete conduit and wire requirements, outlet and junction box sizes and power requirements, for the following systems:
1. Fire Alarm System
 2. Generator and Automatic Transfer Switch(es)

3. Grounding and Bonding System

- H. For any shop drawing requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold Contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return for any reason.
- I. Prepare and submit a detailed schedule of values indicating the Contract costs for the major work items. Provide additional detail and information as requested by the Engineer.
- J. Submit the following Shop Drawings to the Utility Company for approval:
 - 1. Automatic Transfer Switch
 - 2. C/T Cabinets
 - 3. Metering (Utility)
 - 4. Switchboard

1.14 DEFINITIONS

- A. *Approve*: To permit use of material, equipment or methods conditional upon compliance with contract documents requirements.
- B. *Building Line*: Exterior wall of building.
- C. *Concealed*: Hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction.
- D. *Conduits* include conduit, all fittings, identification, and other accessories relative to such conduit.
- E. *Contractor*: The Electrical Contractor and any of his subcontractors, vendors, suppliers, or fabricators.
- F. *EPDM*: Ethylene-propylene-diene terpolymer rubber
- G. *Exposed*: Not installed underground or *concealed* as defined above.
- H. *Finished Spaces*: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.
- I. *Furnish and install or provide*: To supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.

- J. *Location, Damp:* Locations protected from water and not subject to saturation with water or other liquids, but subject to moderate degrees of moisture. Examples of such locations include interior locations such as basements, crawlspaces, attics, cold-storage rooms, etc.
- K. *Location, Dry:* A location not normally subject to dampness or wetness. A dry location may temporarily be subject to dampness or wetness during building construction.
- L. *Location, Wet:* Locations subject to saturation with water or other liquids, locations exposed to weather, and installations underground or in concrete slabs or masonry in direct contact with the Earth. Examples of such locations include all exterior locations (including those under canopies, roofed open porches, etc...) commercial kitchens, and vehicle washing areas.
- M. *NBR:* Acrylonitrile-butadiene rubber.
- N. *Review:* Limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

1.15 RECORD DRAWINGS

- A. Upon completion of the electrical installations, the Contractor shall deliver to the Architect one complete set of prints of the electrical Contract Drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.
- B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into record drawings prior to delivering the same to the Architect.

1.16 WARRANTY

- A. Contractor's attention is directed to warranty obligations contained in the General Conditions.
- B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer's warranties shall be included in the operations and maintenance manuals.
- C. The Contractor guarantees for a two year period from the time of final acceptance by the Owner:
 - 1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.
 - 2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.

3. That the Contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The Contractor shall also make good all damages caused to their work or materials in the process of complying with this section.
4. That the entire work shall be water-tight and leak-proof.

1.17 OPERATIONS AND MAINTENANCE MANUALS

- A. The Contractor shall have prepared six (6) copies of the Operations and Maintenance Manual and deliver these copies of the manual to the Owner. The manual shall be as specified herein. The manual must be approved and will not be accepted as final until so stamped.
- B. The manual shall be bound in a three-ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front: *Operations and Maintenance Manual – Bayard Middle School Phase 1 - Electrical*. No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.
- C. Provide the following data in the manual:
 1. As first entry, an approved letter indicating the starting/ending time of Contractor's warranty period.
 2. Maintenance operation and lubrication instructions on each piece of equipment furnished.
 3. Complete catalog data on each piece of electrical equipment furnished including approved Shop Drawing/Submittal with Engineer's Comments (if any).
 4. Manufacturer's extended limited warranties on equipment.
 5. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.
 6. Provide supplier and subcontractor's names, address, and phone number.
 7. Catalog data of all equipment, starters, etc. shall include wiring diagrams, parts list and assembly drawing.
 8. Access panel charts with index illustrating the location and purpose of access panels.
 9. Approved Electrical Certificates.
 10. Start-up reports for equipment.

- D. Submit Operations and Maintenance Manual prior to anticipated date of Substantial Completion for Engineer review and approval. Substantial Completion requires that Operations and Maintenance Manuals be reviewed and approved.
- E. Post one (1) copy of all instructions, lists, charts and diagrams at the equipment mounted under glass or approved plastic cover.
- F. Deliver all instruction materials to the Owner prior to the formal instruction period.
- G. Upon completion of all work, thoroughly instruct the Owner's representatives in the proper operation and maintenance of all electrical equipment and systems.
- H. Instructions shall be done only after completed systems have been put into operation and tested for proper operation and performance.
- I. Instructions shall be given only by experts in the equipment or system and shall include descriptions and demonstrations of procedures of operation, data record keeping, etc.
- J. Furnish the necessary technicians, skilled workers, and helpers to operate the electrical systems and equipment of the entire project for one 8-hour day.
- K. Where specified in technical sections, provide longer periods required for specialized equipment.
- L. Instruct the Owner or designated personnel in operation, maintenance, lubrication, and adjustment of systems and equipment.
- M. The Operations and Maintenance Manual shall be available at the time of the instructions, for use by Instructors and Owner personnel.
- N. Schedule the general and specialized instruction periods for a time agreed upon by the Owner and Engineer.

1.18 INSTALLATION AND COORDINATION DRAWINGS

- A. Prepare, submit and use composite installation and coordination drawings to assure proper coordination and installation of the work. Drawings shall include, but not be limited to the following:
 - 1. Mechanical Rooms indicating transformers, panelboards, enclosures, boxes, conduits, mechanical equipment, ductwork, and piping, etc...
 - 2. Electrical Rooms indicating switchboards, panelboards, enclosures, boxes, transformers, conduits, wireways, etc...
- B. Draw plans to a scale not less than ¼ inch equals one foot. Include plans, sections and elevations of the proposed work, showing all equipment (mechanical, plumbing and electrical), conduit and wiring in the areas involved. Fully dimension all work, horizontally

and vertically. Show coordination with other work including piping, ductwork and other mechanical work, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.

- C. Identify all equipment and devices on wiring diagrams. Where field connections are shown to factory-wired terminals, furnish manufacturer's literature showing internal wiring of equipment.
- D. Prepare, submit, and use scaled layout drawings indicating dimensions, clearances, and actual equipment dimensions. Layout Drawings shall include, but not be limited to the following:
 - 1. Pad-mounted equipment and equipment connections.
 - 2. Underground conduits, ductbanks, and building penetrations.
- E. Prepare scaled coordination drawings in accordance with the Specifications. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
 - 1. Indicate the proposed locations of power, lighting, and all special system raceways, equipment, and materials. Include the following:
 - a. Working space and dedicated space clearances per the NEC.
 - b. Clearances for equipment disassembly required for periodic maintenance.
 - c. Exterior wall and foundation penetrations.
 - d. Fire-rated wall and floor penetrations.
 - e. Equipment connections and support details.
 - f. Sizes and locations of required concrete bases.
 - 2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction, including, but not limited to, the following: Major conduits and feeders.
 - 3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 - 4. The successful Bidder shall be responsible for indicating all raceways described in notes or indicated by home run symbols.
 - 5. The successful Bidder shall check all trades' Drawings, including Civil, Architectural, Structural, Plumbing, and Mechanical, to avoid possible demolition and installation conflicts.

PART 2. PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. Bridgeport Fittings, Inc.
 - c. Calpico, Inc.
 - d. GS Metals Corporation
 - e. Metraflex Co.
 - f. O-Z/Gedney
 - g. Pipeline Seal and Insulator, Inc.
 - h. Raco, Inc.
 - 2. Sealing Elements: EPDM, NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Stainless Steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 FOAM DUCT SEALANT

- A. Description: Two-part, high-expansion foam duct sealant to keep water, acids, dust, gases, insects and rodents out of ducts (conduits).
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. American Polywater Corporation
- C. Basis of Design: FST Foam Sealant by American Polywater Corporation.
- D. The foam duct sealant shall be a two-part "blown" urethane foam with 98% closed cell content.
- E. The foam duct sealant shall have a compressive strength of 300 pounds (ASTM D1691), a tensile strength of 250 pounds (ASTM D1623), and a flexural strength of 450 pounds (ASTM D790).
- F. The foam duct sealant shall be compatible with common cable jacket materials. The cured foam shall be an inert solid that does not affect jacket materials.
- G. The foam duct sealant shall withstand temperatures from -20 degrees Fahrenheit to 200 degrees Fahrenheit and shall not lose function in direct sunlight
- H. The foam duct sealant shall be chemically resistant to gasoline, oils, dilute acids and bases, and most unsaturated hydrocarbons.
- I. The foam duct sealant shall foam and react in five to ten minutes at 70 degrees Fahrenheit.
- J. When installed, the sealant shall be capable of holding 7.25 psi air pressure continuously (equivalent of 16.4 feet water-head pressure).

2.5 FASTENERS

- A. All fasteners located in public spaces including classrooms, corridors, lobbies, toilet rooms, etc., shall be provided with tamper proof fasteners. Provide Pin Phillips hardware as manufactured by Challenge Industries or approved equal.

PART 3. EXECUTION

3.1 TEMPORARY FACILITIES

- A. General: Refer to the Division 01 Sections for general requirements of temporary facilities.
- B. Description: Furnish and install the necessary metering and distribution equipment for an adequate, 3-phase, 4-wire temporary electrical service and all temporary wiring and lighting, including step-down or step-up dry-type transformers as required. Exact requirements for temporary service will be determined by the General Contractor.
- C. Attention is directed to the Occupational Safety and Health Act (OSHA), Americans with Disabilities Act (ADA) and National Electrical Code (NEC) requirements for electrical work on construction sites.
- D. The Contractor shall pay for all energy charges for temporary service.

3.2 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Install equipment with working space and dedicated space in strict accordance with 2008 NEC Article 110.26.
- 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. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- G. Verify exact electrical service requirements for each piece of equipment receiving electrical connections. Provide proper service for each.
- H. Include any and all items required by the National Electrical Code and/or field conditions for the proper connection and installation of each piece of equipment.
- I. Right of Way: Give to piping systems installed at a required slope.
- J. Coordinate electrical work with architectural items and equipment by others. Typical equipment refers to, but is not limited to, the following:

1. Countertops, Casework and Cabinets.
 - a. Do not install outlets, switches, etc., behind casework, cabinets, etc.
 - b. Data, phone, and other low voltage system outlets shall be mounted above the counter tops to match power outlets in the same areas.
 - c. Coordinate counter top outlets with drilling of casework/counters.
 - d. Coordinate surface raceways and outlets above and below counters with approved casework shop drawings to avoid conflicts with sinks and other appurtenances.

3.3 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. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. 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.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. 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 of Division 07 Section 079200 *Joint Sealants*.
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements of Division 26 Section 260528 *Electrical Firestopping*.
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

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

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

3.4 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 26 Section, *Electrical Firestopping*.

3.6 SUPPORTS, HANGERS AND FOUNDATIONS

A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.

B. Supports, hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. All exterior hangers shall be constructed of stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.

C. Installing Equipment Foundations (Housekeeping Pads):

1. Provide four (4) inch high concrete foundations (housekeeping pads) for all floor-mounted equipment extending a minimum of 6 inches beyond equipment bases for interior equipment and a minimum of 12 inches beyond equipment bases for exterior equipment, unless otherwise noted. Furnish foundations, bolts, sleeves, and appurtenances and set under the section furnishing the equipment. Anchor the concrete foundations by dowels inserted into the floor slab. Provide welded wire fabric reinforcement, chamfer exposed edges and corners, and finish exposed surfaces smooth.

2. Unless otherwise specified, provide all concrete work required in accordance with the requirements of Division 03.

3. Equipment shall be properly aligned. Level and grout equipment where necessary. Support conduit independently of equipment and so as not to cause a strain or thrust.
 4. Determine exact location of all equipment, foundations, and supports after Shop Drawings of equipment have been approved.
- D. Where new concrete housekeeping pads are placed on existing concrete, saw cut the existing concrete to the perimeter dimension of the new pad to a depth of ½ inch. Break out the top ½ inch area of the existing concrete. Add stubs of #4 rebar angled into the existing concrete at a depth of approximately 50 percent of the existing slab thickness. The top portion of the rebar stub shall extend into the new pad by approximately 50 percent of its thickness. Furnish one rebar stub per every two square feet of new pad. Chemically bond the new concrete to the existing concrete.

3.7 PROVISIONS FOR ACCESS

- A. The Contractor shall provide access panels and doors for all concealed equipment, and other devices requiring maintenance, service, adjustment or manual operation.
- B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.
 1. Acoustical or Cement Plaster: Style B
 2. Hard Finish Plaster: Style K or L
 3. Masonry or Dry Wall: Style M
- C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.
- D. Access panels, doors, etc. described herein shall be furnished under the section of Specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing Contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.
- E. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.

- F. Provide sufficient access and working space for repair and maintenance about all lighting and electrical equipment to permit ready and safe operation and maintenance of such equipment OSHA 29 CFR 1910 Subpart D and 1910.303(g).

3.8 PAINTING AND FINISHES

- A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.
- B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.
- C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.
- D. Protect all finishes and restore any finishes damaged as a result of work under Division 26 to their original condition.
- E. The preceding requirements apply to all work, whether exposed or concealed, as defined herein.
- F. Remove all construction marking and writing from exposed equipment, ductwork, piping and building surfaces. Do not paint manufacturer's labels or tags.
- G. All exterior equipment and conduits shall be painted to match adjacent surface in color as selected by Architect, unless otherwise indicated by the Architect.
- H. All exposed conduit, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

3.9 COLOR SELECTION

- A. Color of finishes shall be as selected by the Architect.

3.10 PROTECTION OF WORK

- A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.
- B. Cover temporary openings in conduits and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver conduits with factory applied end caps.
- C. Cover or otherwise protect all finishes.
- D. Replace damaged materials, devices, finishes and equipment.
- E. Protect stored conduits from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.11 OPERATION OF EQUIPMENT

- A. Clean all systems and equipment prior to initial operation for testing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.
- B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.
- C. Submit factory start-up sheets or field start-ups sheets for all equipment prior to the commencement of testing.
- D. Do not use electrical systems for temporary services or during construction, unless approved by Owner in writing. Refer to Division 01 Section 015000 *Temporary Facilities and Controls*.
- E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items.

3.12 TESTING AND ADJUSTMENT

- A. Perform all tests which are specified or required to demonstrate that the work is installed and operating properly. Where formal tests are required, give proper notices and perform all necessary preliminary tests to assure that the work is complete and ready for final test.
- B. Adjust all systems, equipment and controls to operate in a safe, efficient and stable manner.
- C. On all circuits, 600 volts or less, provide circuits that are free from ground faults, short circuits and open circuits.
- D. Other tests of a specific nature for special equipment shall be as specified under the respective equipment.
- E. Submit all test results to the Architect/Engineer for approval.

3.13 WALL AND FLOOR PENETRATIONS

- A. All penetrations of partitions, ceilings, roofs and floors by or conduit under Division 26 shall be sleeved, sealed, and caulked airtight for sound and air transfer control. Penetrations of mechanical room partitions, ceilings, and floors shall be as specified in Division 26.
- B. All penetrations of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 26 Section, *Electrical Firestopping*.

- C. Where penetrating through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these Specifications.
- D. Provide conduit escutcheons for all exposed conduit penetrations in finished interior spaces and all exposed exterior penetrations. Escutcheons shall match those provided under Division 23.
- E. Conduit sleeves:
 - 1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
 - 2. Twenty-two (22) gauge galvanized steel elsewhere.

3.14 EQUIPMENT BY OTHERS

- A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions or furnished by the Owner. Connections shall be complete in all respects to render this equipment functional to its fullest intent.
- B. It shall be the responsibility of the supplier of the equipment to furnish complete instructions for connections. Failure to do so will not relieve the Contractor of any responsibility for improper equipment operation.

3.15 PHASING

- A. Refer to Architectural Specifications and Contract Drawings for any required phasing.
- B. Maintain building egress and traffic ways at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and Authorities Having Jurisdiction (AHJ).
- C. Provide dust barriers/partitions, penetration closures, etc, to ensure safety of building occupants and protection of existing surroundings.
- D. The Building shall remain watertight at all times.
- E. Refer to phasing plans for additional requirements.
- F. Within thirty days of Award of Contract, the Contractor shall submit a minimum of six (6) copies of the proposed Phasing Plan (Drawings and detailed written description) to the Architect for review and approval based on the general and specific requirements indicated on the Drawings and Specifications. The phasing plan shall reflect the work of all trades. The phasing plan shall be updated as often as needed (i.e. major deviations and/or modified sequence of events) and reviewed during each progress meeting so the Owner and Architect can be aware of the areas of construction and progress as it relates to the approved schedule.

- G. While work is in progress, except for designated short intervals during which connections are made, continuity of service shall be maintained to all existing systems. Interruptions shall be coordinated with the Owner as to time and duration. The Contractor shall be responsible for any interruptions to service and shall repair any damages to existing systems caused by his operations.

3.16 OUTAGES

- A. Provide a minimum of fourteen (14) days notice to schedule outages. The Contractor shall include in their bid outages and/or work in occupied areas to occur on weekends, holidays, or at night. Coordinate and get approval of all outages with the Owner.
- B. Submit *Outage Request Form*, attached at the end of this Section, to Owner for approval.

3.17 CUTTING AND PATCHING

- A. Accomplish all cutting and patching necessary for the installation of work under Division 26. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike manner. Restore disturbed work to match and blend with existing construction and finish, using materials compatible with the original. Use mechanics skilled in the particular trades required.
- B. Do not cut structural members without approval from the Architect or Engineer.

3.18 PENETRATION OF WATERPROOF CONSTRUCTION

- A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.
- B. Where conduits penetrate roofs, flash pipe with Stoneman *Stormtite*, Pate or approved equal, roof flashing assemblies with skirt and caulked counter flashing sleeve.
- C. Furnish and install pitch pockets or weather tight curb assemblies where required.
- D. Furnish and install curbs, vent assemblies, and sleeves specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions. The Contractor shall be responsible for sleeve sizes and locations. All roof penetrations shall be installed in accordance with manufacturer's instructions, the National Roofing Contractors Association, SMACNA, and as required by other divisions of these Specifications.

3.19 CONCRETE AND MASONRY WORK

- A. Furnish and install concrete and masonry work for equipment foundations, supports, pads, and other items required under Division 26. Perform work in accordance with requirements of Division 03 and other applicable Divisions of these Specifications.

- B. Concrete shall test not less than 3,000 psi compressive strength after 28 days.
- C. Grout shall be non-shrink, high strength mortar, free of iron of chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.
- D. Installing Outdoor Equipment Foundations:
 - 1. Provide equipment foundations as indicated in Article “Supports, Hangers, and Foundations” in this Section.
 - 2. Place reinforcement accurately in position shown, securely fasten and support to prevent displacement before or during pouring. Clean, bend, place, and splice reinforcement in accordance with approved shop drawings. Lap ends and sides of mesh reinforcement in slabs not less than one inch. Coverage of main reinforcing shall be as follows:
 - a. Slabs - 3/4 inch
 - b. Concrete poured against earth - 3 inches
 - c. Other locations - 2 inches
 - 3. Properly align, level, and grout all equipment where necessary.

3.20 CONNECTIONS AND ALTERATIONS TO EXISTING WORK

- A. Unless otherwise noted on the Drawings, where existing electrical work is removed, including hangers, to a point below finished floors or behind finished walls and capped, such point shall be far enough behind finished surfaces to allow for installation of normal thickness of required finish material.
- B. Where work specified in Division 26 connects to existing equipment, conduits, etc., Contractor shall perform all necessary alterations, cuttings, fittings, etc., of existing work as may be necessary to make satisfactory connections between new and existing work, and to leave completed work in a finished and workmanlike condition.
- C. Where the work specified under Division 26, or under other Divisions, requires relocation of existing equipment, conduit etc., Contractor shall perform all work and make necessary changes to existing work as may be required to leave completed work in a finished and workmanlike condition.
- D. Where the relocation of existing equipment is required for access or the installation of new equipment, the Contractor shall temporarily remove and/or relocate and re-install as required to leave the existing and new work in a finished and workman like condition.

3.21 COORDINATION

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

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 3. To allow right of way for piping and conduit installed at required slope.
 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
 5. To provide working space and dedicated space clearances per 2008 NEC Article 110.26.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in this Section, Article “Provisions for Access”.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 26 Section 260528 *Electrical Firestopping*.

3.22 DEMOLITION

- A. Unless otherwise noted all existing equipment, conduit, wire, etc., shall remain.
- B. Where existing equipment is indicated to be removed, all associated conduit, power, controls, insulation, hangers, supports and housekeeping pads, etc..., shall also be removed. Patch, paint and repair walls/roof/floor to match existing and/or new finishes.
- C. The Contractor shall be responsible for visiting the site and determining the existing conditions in which the work is to be performed.
- D. Refer to phasing plans for additional requirements.
- E. Where any abandoned conduits in existing floors, walls, pipe tunnels, ceilings, etc., conflict with new work, remove abandoned conduits as necessary to accommodate new work.
- F. The location of all existing equipment, conduits etc., indicated is approximate only and shall be checked and verified. Provide all new electrical work required to connect to or clear existing work as applicable.
- G. Maintain egress at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and the Authorities Having Jurisdiction (AHJ).
- H. Make provisions and include in bid all costs associated with confined entry/space requirements in crawl spaces and all other applicable OSHA regulations.

- I. Where required to maintain the existing systems in operation, temporarily backfeed existing systems from new equipment. Contractor shall temporarily extend existing conduit systems to new conduit systems.
- J. At completion of project all temporary conduit, wires, etc., shall be removed in their entirety.
- K. Existing conduit, equipment, wiring, etc., not required for re-use or re-installation in this project, shall be removed from the project site.
- L. Deliver to the Owner, on the premises where directed, existing equipment and materials which are removed and which are desired by the Owner or are indicated to remain the property of the Owner.
- M. All other materials and equipment which are removed shall become property of the Contractor and shall be promptly removed, from the premises, and disposed of by the Contractor, in an approved manner. Contractor shall be responsible for proper disposal of all removed equipment containing PCB's.
- N. Where conduit and wiring are removed, remove all conduit hangers which were supporting the removed conduit. Patch the remaining penetration voids with like materials and paint to match existing construction.
- O. Where required, provide and coordinate removal and re-installation of existing equipment. Take care to protect materials and equipment indicated for reuse. Contractor shall repair or replace items which are damaged. Contractor shall have Owner's representative present to confirm condition of equipment prior to demolition.
- P. Before demolition begins, and in the presence of the Owners representative, test and note all deficiencies in all existing systems affected by demolition but not completely removed by demolition. Provide a copy of the list of system deficiencies to the Owner and the Engineer. Videotape existing conditions in each space prior to beginning demolition work.
- Q. The Owner shall have the first right of refusal for all fixtures, devices and equipment removed by the Contractor.
- R. All devices and equipment designated by the Owner to remain the property of the Owner shall be moved and stored by the Contractor at a location on site as designated by the Owner. It shall be the Contractor's responsibility to store all devices and equipment in a safe manner to prevent damage while stored.
- S. All existing equipment refused by the Owner shall become the property of the Contractor and shall be removed from the site by the Contractor in a timely manner and disposed of in a legal manner.
- T. Work Abandoned in Place: Cut and remove conduit a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.

- U. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.
- V. Terminate services and utilities in accordance with local laws, ordinances, rules and regulations.

3.23 EXCAVATION AND BACKFILLING

- A. General:
 - 1. Perform all necessary excavation, or installation of work under Division 26, in whatever materials or conditions encountered, using suitable methods and equipment.
 - 2. Accurately establish required lines and grades and properly locate the work.
 - 3. Determine the locations of all existing utilities before commencing the work.
- B. Excavation: (Refer also to other portions of the Specifications)
 - 1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.
 - 2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, OSHA, and MOSHA Guidelines.
 - 3. Keep excavations dry. Protect excavations from freezing.
- C. Backfilling: (Refer also to other portions of the Specifications)
 - 1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.
 - 2. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.
 - 3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.
 - 4. Do not backfill against frozen material. Do not use frozen material for backfill.

END OF SECTION

OUTAGE REQUEST

DATE APPLIED: _____ BY: _____

DATE FOR OUTAGE: _____ FIRM: _____

START OUTAGE-TIME: _____ DATE: _____

END OUTAGE - TIME: _____ DATE: _____

AREAS AND ROOMS: _____

FLOOR(S): _____

AREA(S): _____

ROOM(S): _____

WORK TO BE PERFORMED: _____

SYSTEM(S): _____

REQUEST APPROVED BY: _____
(FOREMAN OR OTHER PERSON IN CHARGE)

(FOR OWNER'S USE ONLY):

APPROVED: _____

YES ____ NO ____ BY: _____ DATE: _____

DATE/TIME-AS REQUESTED: _____ OTHER: _____

OWNER'S PRESENCE REQUIRED: _____

YES: ____ NO: ____ NAME: _____

POINT OF CONTACT: _____ PHONE: _____

DIVISION 26 SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
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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 and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Common ground bonding with lightning protection system.
 - 3. Fence grounding.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Grounding arrangements and connections for separately derived systems.
 - 4. Grounding for sensitive electronic equipment.
- C. Qualification Data: For testing agency and testing agency's field supervisor.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
 - 1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, grounding connections for separately derived systems based on NETA MTS.

- a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
- b. Include recommended testing intervals.

1.4 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 UL 467 for grounding and bonding materials and equipment.

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 (6 mm) in diameter, unless otherwise noted.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor, unless otherwise noted.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches (6 by 50 mm) in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

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

- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- G. Conduit Hubs: Mechanical type, terminal with threaded hub.
- H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with socket set screw.
- I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- J. Lay-in Lug Connector: Mechanical type, aluminum terminal with set screw.
- K. Straps: Solid copper, copper lugs. Rated for 600 A.
- L. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- M. Water Pipe Clamps:
 - 1. Mechanical type, two pieces with zinc-plated bolts.
 - a. Material: Die-cast zinc alloy.
 - b. Listed for direct burial.
 - 2. U-bolt type with malleable-iron clamp and copper ground connector.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, sectional type; 3/4-inch by 10 feet (19 mm by 3 m) in diameter.
- B. Ground Plates: 1/4 inch (6 mm) thick, hot-dip galvanized.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.

- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 30 inches (900 mm) below grade.
- C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

3.3 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.4 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.5 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits of the same type as the circuit conductors. Install in same conduit with circuit conductors.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-24-inch (6-by-50-by-600-mm) grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- E. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.6 FENCE GROUNDING

- A. Fence Grounding: Install at maximum intervals of 750 feet (225 m).
 - a. Gates and Other Fence Openings: Ground fence on each side of opening.
 - 1) Bond metal gates to gate posts.

- 2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.
- B. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.
- C. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 2 AWG conductor. Connect conductor to each fence component at grounding location.
- D. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
- E. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.7 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Where ground lug and bonding conductors installed indoors exceed 3 feet in length, install in EMT conduit.
- B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 30 inches (900 mm) below finished floor or final grade, unless otherwise indicated.
 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 2. Use exothermic welds for all below-grade connections.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ductbanks," and shall be at least 12 inches (300 mm) deep, with cover.
 1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor. Provide all test wells with twist lock cover, Harger#GAW910 or approved equal.

- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- H. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet (6.0 m) long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.
- I. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

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

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 4. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- C. Grounding system will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System: 5 ohms.
 - 2. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm.
 - 3. Substations and Pad-Mounted Equipment: 5 ohms.
 - 4. Manhole Grounds: 10 ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

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DIVISION 26 SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
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SECTION 26 05 29
HANGERS AND SUPPORTS 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. Hangers and supports for electrical equipment and systems.
 - 2. Concrete Bases
- B. Related Sections include the following:
 - 1. Metal Fabrications – For requirements for miscellaneous metal items involved in supports and fastenings.
 - 2. Joint Sealants – For requirements for firestopping at sleeves through walls and floors that are fire barriers.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.
 - 1. Hangers. Include product data for components.
 - 2. Slotted support systems.
 - 3. Equipment supports.
 - 4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: For hangers and supports for electrical systems.
 - 1. Include design calculations and details of hangers.
 - 2. Include design calculations for seismic restraints.
- D. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide slotted metal angle and U-channel systems by one of the following:
 - a. Thomas & Betts Corporation.
 - b. Alstrut.
 - c. Unistrut; Diversified Products
 - d. Power-Strut.
 - 2. Manufacturers: Subject to compliance with requirements, provide conduit sealing bushings and accessories by one of the following:
 - a. Bridgeport Fittings
 - b. GS Metals, Corporation
 - c. O-Z / Gedney
 - d. Raco, Inc.
 - 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - 6. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

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

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

- C. Submit structural calculations for load and strength of each component and detailing of each assembly.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1, NECA 101 and NECA 105 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- E. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Existing Concrete: Expansion anchor fasteners.
 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 6. To Light Steel: Sheet metal screws.
 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Comply with requirements in Section 099113 "Exterior Painting," Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for

cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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

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DIVISON 26 SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
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SECTION 26 05 33
RACEWAYS 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. Section 262726 "Wiring Devices" for multi-outlet assemblies.
 - 2. Section 260543 Section "Underground Ductbanks" for exterior ductbanks, and underground utility construction.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. LFNC: Liquidtight flexible nonmetallic conduit.
- F. 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.
- 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.
- D. Source quality-control test reports.
- 1.5 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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 1. AFC Cable Systems, Inc.
 2. Alflex Inc.
 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 5. Electri-Flex Co.
 6. Manhattan/CDT/Cole-Flex.
 7. Maverick Tube Corporation.
 8. O-Z Gedney; a unit of General Signal.
 9. Wheatland Tube Company.
 10. Steel City.
- B. Rigid Steel Conduit: ANSI C80.1.

- C. IMC: ANSI C80.6.
- D. EMT: ANSI C80.3.
- E. FMC: Zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket.
- G. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 - 2. Fittings for EMT: Steel compression type.
 - 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- H. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

- 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. AFC Cable Systems, Inc.
 - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 3. Arnco Corporation.
 - 4. CANTEX Inc.
 - 5. CertainTeed Corp.; Pipe & Plastics Group.
 - 6. Condux International, Inc.
 - 7. ElecSYS, Inc.
 - 8. Electri-Flex Co.
 - 9. Lamson & Sessions; Carlon Electrical Products.

10. Manhattan/CDT/Cole-Flex.
 11. RACO; a Hubbell Company.
 12. Thomas & Betts Corporation.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- C. LFNC: UL 1660.
- D. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.
- E. Fittings for LFNC: UL 514B.

2.3 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. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Metal Floor Boxes: Cast metal (slab on grade application) or sheet metal, fully adjustable, rectangular, listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Nonmetallic Floor Boxes: Nonadjustable, round.
- H. Metallic Recessed Access-Floor Boxes and Recessed Floor Box Covers:
 - 1. Description: Floor box with provisions for mounting wiring devices below floor surface and floor box cover with provisions for passage of cords to recessed wiring devices mounted within floor box.
 - 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. FSR, Inc.
 - 3. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL 514A and UL Category Control Number QCIT.
- I. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.
- J. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).
 - 1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- K. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- L. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

- M. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- N. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep), except shallow boxes shall be permitted to accommodate framing.
- O. Gangable boxes are allowed.
- P. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- Q. Cabinets:
 - 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

2.4 WIREWAYS AND AUXILIARY GUTTERS

A. Metal Wireways and Auxiliary Gutters:

- 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - b. EGS/Appleton Electric.
 - c. Erickson Electrical Equipment Company.
 - d. Hoffman.
 - e. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 - f. O-Z/Gedney; a unit of General Signal.
 - g. RACO; a Hubbell Company.
 - h. Robroy Industries, Inc.; Enclosure Division.
 - i. Scott Fetzer Co.; Adalet Division.
 - j. Spring City Electrical Manufacturing Company.
 - k. Thomas & Betts Corporation.
 - l. Walker Systems, Inc.; Wiremold Company (The).
 - m. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- 2. Applicable Standards:

- a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- b. General Characteristics:
 - 1) Reference Standards: UL 870 and UL Category Control Number ZOYX.
 - 2) Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
 - 3) Finish: Manufacturer's standard enamel finish.
- c. Options:
 - 1) Degree of Protection: Type 12 unless otherwise indicated.
 - 2) Wireway Covers: Screw-cover type unless otherwise indicated.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

- 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
- 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of fiberglass.

- 1. Standard: Comply with SCTE 77.
- 2. Color of Frame and Cover: Gray.
- 3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
- 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
- 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- 6. Cover Legend: Molded lettering, "ELECTRIC."
- 7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
- 8. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.6 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
 - 1. Exposed Conduit: Rigid steel conduit.
 - 2. Concealed Conduit, Aboveground: Rigid steel conduit.
 - 3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried, unless otherwise noted.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Comply with the following indoor applications, unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT, support 6' on center maximum for sizes over 2-inches.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT, support 6' on center maximum for sizes over 2-inches.
 - 3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT, support 6' on center maximum for sizes over 2-inches.

5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: Rigid steel conduit.
 7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway.
 8. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
 9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
 3. Fasten rigid steel conduit with threaded galvanized steel fittings, double locknuts, and insulated bushings. Insulated bushings shall be OZ Gedny Type B.
 4. Exterior rigid steel conduit box connections shall be made with a Meyers Hub fitting only. Meyers Hub fittings shall be Cooper Crouse-Hind type.
 5. All LB's, C, and T condulets shall be constructed of malleable iron. No aluminum/die pot metal type permitted.
 6. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
 7. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

3.2 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. 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.
- C. Complete raceway installation before starting conductor installation.

- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit within CMU walls, finished walls, ceilings, and floors, unless otherwise indicated. Conduits to surface mounted panelboards in electrical equipment rooms may be installed exposed.
- H. Raceways Below Slabs:
 - 1. Refer to section 260543 for additional requirements.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Do not embed threadless fittings in concrete unless specifically approved by Engineer for each specific location.
 - 4. Change from PVC to GRC before rising above floor.
 - 5. Arrange stub-ups so curved portions of bends are not visible above finished slab.
 - 6. Conduits in close proximity to each other shall be located and wrapped with wire mesh to prevent cracking of slab.
 - 7. Permitted below slab where specifically indicated below and specifically indicated on the Drawings.
 - a. Feeders to panelboards for slab on grade application.
 - b. Branch circuits to surface mounted panels in Shop Areas.
 - c. Branch circuit permitted below slab for first floor floor box locations only. Branch circuit conduits shall stub-up at nearest wall or panel, whichever is closer.
- I. Stub-Ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- J. 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.

- K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- L. 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.
- M. 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 an underground service raceway enters a building or structure.
 - 3. Conduit extending from interior to exterior of building.
 - 4. Conduit extending into pressurized duct and equipment.
 - 5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 - 6. Where otherwise required by NFPA 70.
- N. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- O. Expansion-Deflection Fittings: Provide an expansion/deflection fitting in each concealed or exposed electrical run crossing a building expansion joint. Fittings shall be complete with bronze end couplings, neoprene sleeve, tinned copper braid integral bonding jumper and stainless steel bands. Expansion/deflection fittings shall be suitable for the size and type of conduit run they connect. Bonding jumper shall comply with NEC and UL requirements.
 - 1. Expansion/deflection fitting shall accommodate the following movements without collapsing or fracturing the conduit and damaging the wires it contains:
 - a. Axial expansion or contraction up to 3/4-inch.
 - b. Angular misalignment of the axes of the conduits up to 30 degrees in all directions.
 - c. Parallel misalignment of the axes of the conduits up to 3/4-inch in all directions.
 - 2. Expansion/Deflection fitting shall be OZ/Gedney Type DX or approved equal by Crouse Hinds (Type XD).
- P. Bushings:

1. Bushings for 1-inch conduit and smaller shall be self-extinguishing thermoplastic type – 150 deg C temperature rating.
 2. Bushings for 1-1/4-inch conduit and larger shall be malleable iron body with 150 deg C insulating ring. Insulating material shall be locked in place and non-removable. Provide O-Z/Gedney Type B.
- Q. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- R. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- S. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- T. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- U. Locate boxes so that cover or plate will not span different building finishes.
- V. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- W. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- X. Set metal floor boxes level and flush with finished floor surface.
- Y. Raceways Penetrating Rooms or Walls with Acoustical Requirements:
1. Seal raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.
- Z. Exposed conduits in finished spaces where there is no ceiling, and where ceiling is perforated, shall be painted, color as selected by architect.

3.3 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 paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
- D. Install handholes with bottom below frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

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

3.5 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.6 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

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UNDERGROUND DUCTBANKS
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SECTION 26 05 43
UNDERGROUND DUCTBANKS

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. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
 - 2. Handholes and boxes.
 - 3. Manholes.

1.3 DEFINITION

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
 - 1. Two or more ducts installed in parallel, with or without additional casing materials.
 - 2. Multiple duct banks.
- D. GRC: Galvanized rigid (steel) conduit.
- E. RNC: Rigid nonmetallic conduit.
- F. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.

3. Accessories for manholes, handholes, boxes, and other utility structures.
 4. Warning tape.
 5. Warning planks.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
1. Duct entry provisions, including locations and duct sizes.
 2. Reinforcement details.
 3. Frame and cover design and manhole frame support rings.
 4. Ladder details.
 5. Grounding details.
 6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 7. Joint details.
- C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
1. Duct entry provisions, including locations and duct sizes.
 2. Cover design.
 3. Grounding details.
 4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
- D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 2. Drawings shall be signed and sealed by a qualified professional engineer.
- E. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.
- F. Qualification Data: For professional engineer and testing agency.
- G. Source quality-control test reports.

- H. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Comply with ANSI C2.
- C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.
- B. General: Clearing work shall not begin until temporary fences, barricades, warning signs and other pedestrian control devices are installed.
- C. Traffic Access:
 - 1. Conduct operations and schedule cleanup in a manner which causes the least possible obstruction and inconvenience to adjacent property owners, pedestrians and vehicular traffic. Furnish, erect, construct and maintain such temporary fences, barriers, lights, reflectors, cones, signs, ramps, etc., that may be necessary to adequately provide separation and warn the public of work in progress and of any existing dangerous conditions. This requirement shall apply continuously and shall not be limited to normal working hours.
 - 2. Maintain continued access to parking areas, roads, abutting properties, and other facilities which the construction will cross.

1.8 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- 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. ARNCO Corp.
 - 2. Beck Manufacturing.
 - 3. Cantex, Inc.
 - 4. CertainTeed Corp.; Pipe & Plastics Group.
 - 5. Condux International, Inc.
 - 6. ElecSys, Inc.
 - 7. Electri-Flex Company.
 - 8. IPEX Inc.
 - 9. Lamson & Sessions; Carlon Electrical Products.

10. Manhattan/CDT; a division of Cable Design Technologies.
 11. Spiraduct/AFC Cable Systems, Inc.
- B. Underground Plastic Utilities Duct: Type EPC-80-PVC and Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- C. Duct Accessories:
1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 2. Warning Tape: Underground-line warning tape specified in Division 26 Section.
 3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.
 - a. Color. Red dye added to concrete during batching
 - b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.
- D. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
- E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

- 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. Carder Concrete Products.
 2. Christy Concrete Products.
 3. Elmhurst-Chicago Stone Co.
 4. Oldcastle Precast Group.
 5. Riverton Concrete Products; a division of Cretex Companies, Inc.
 6. Utility Concrete Products, LLC.
 7. Utility Vault Co.
 8. Wausau Tile, Inc.

- B. Comply with ASTM C 858 for design and manufacturing processes.
- C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
 - 1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 - 2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 3. Cover Legend: Molded lettering, "ELECTRIC," "TELEPHONE," and/or as indicated for each service.
 - 4. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
 - 5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches (300 mm).
 - b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
 - 6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 - 7. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
 - 8. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Description: Comply with SCTE 77.
1. Color: Gray.
 2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural 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. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
 7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 8. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.
- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. NewBasis.
- C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. Christy Concrete Products.
 - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

2.5 PRECAST MANHOLES

- 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. Carder Concrete Products.
 2. Christy Concrete Products.
 3. Elmhurst-Chicago Stone Co.
 4. Oldcastle Precast Group.
 5. Riverton Concrete Products; a division of Cretex Companies, Inc.
 6. Utility Concrete Products, LLC.
 7. Utility Vault Co.
 8. Wausau Tile, Inc.
- B. Comply with ASTM C 858, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.
1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
- C. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50 mm) thick, for future conduit entrance and sleeve for ground rod.
- D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.6 UTILITY STRUCTURE ACCESSORIES

- 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. Bilco Company (The).
 2. Campbell Foundry Company.
 3. Carder Concrete Products.
 4. Christy Concrete Products.
 5. East Jordan Iron Works, Inc.
 6. Elmhurst-Chicago Stone Co.
 7. McKinley Iron Works, Inc.
 8. Neenah Foundry Company.
 9. NewBasis.
 10. Oldcastle Precast Group.
 11. Osburn Associates, Inc.
 12. Pennsylvania Insert Corporation.
 13. Riverton Concrete Products; a division of Cretex Companies, Inc..
 14. Strongwell Corporation; Lenoir City Division.
 15. Underground Devices, Inc.
 16. Utility Concrete Products, LLC.
 17. Utility Vault Co.
 18. Wausau Tile, Inc.
- B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches (737 mm).
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
 2. Cover Legend: Cast in. Selected to suit system.
 - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
 - b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
 3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.
- C. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
- D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.

1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.
- E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- (32-mm-) diameter eye, rated 2500-lbf (11-kN) minimum tension.
- F. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
 1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.
- G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (32 mm) minimum at base.
 1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.
- H. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.
- I. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.
 1. Stanchions: T-section or channel; 2-1/4-inch (57-mm) nominal size; punched with 14 holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.
 2. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 18 inches (460 mm) with 250-lb (114-kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- J. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
 1. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with minimum of 9 holes for arm attachment.
 2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (508 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.

- K. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- L. Fixed Manhole Ladders: Arranged for attachment to wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.
- M. Portable Manhole Ladders: UL-listed, heavy-duty fiberglass specifically designed for portable use for access to electrical manholes. Minimum length equal to distance from deepest manhole floor to grade plus 36 inches (900 mm). One required.
- N. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater. Two required.

2.7 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by a independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

- C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- B. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.
- C. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-80-PVC where direct-buried, RNC, NEMA Type EPC-40-PVC where concrete-encased, unless otherwise noted.
- D. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.
- E. Underground Ducts Crossing Paved Paths, walks, driveways and roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.
- F. Ducts for electrical feeders over 600V: RNC, NEMA Type EPC-80-PVC where direct-buried, RNC, NEMA Type EPC-40-PVC where concrete-encased, unless otherwise noted.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.
 - 5. Cover design load shall not exceed the design load of the handhole or box.
- B. Manholes: Precast or cast-in-place concrete.
 - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.

2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Division Section "Earthwork" but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division Sections "Lawns and Grasses" and "Exterior Plants."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.5 DUCT AND DUCTANK INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
- C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 25 feet (7.5 m), both horizontally and vertically, at other locations, unless otherwise indicated. Provide minimum radius for utility primary feeders as required by the utility company.
- D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- E. Duct Entrances to Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.
 1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
 3. Grout end bells into structure walls from both sides to provide watertight entrances.

- F. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."
- G. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- H. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.
- I. Concrete-Encased Ducts: Support ducts on duct separators.
 - 1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - 2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.
 - 3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
 - 4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 - 5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

6. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
9. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

J. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division Section "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
4. Install backfill as specified in Division Section "Earth Moving."
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division Section "Earth Moving."

6. Install ducts with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
11. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above direct-buried ducts and duct banks, placing them 24 inches (600 mm) o.c. Align tape parallel to and within 3 inches (75 mm) of centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional planks 12 inches (300 mm) apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Install handholes with bottom below the frost line, below grade.
2. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
3. Where indicated, cast handhole cover frame integrally with handhole structure.

- C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
 - 1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 - 2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
- E. Dampproofing: Apply dampproofing to exterior surfaces of handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07. After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, as required for installation and support of cables and conductors and as indicated.
- G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (97 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- H. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
- D. Install handholes and boxes with bottom below the frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.
 - 2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

3.8 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding of Electrical Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 - 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding of Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.10 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

DIVISION 26 SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS
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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. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, 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 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field for normal feeders, black letters on a yellow field for emergency feeders.
 - 2. Legend: Indicate voltage and system or service type.
- C. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
 - 1. Black letters on an orange field for normal circuits, black letters on a yellow field for emergency circuits.
 - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.3 CONDUCTOR 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.

2.4 UNDERGROUND-LINE WARNING TAPE

- A. Tape: Permanent, bright-colored, continuous-printed polyethylene tape.
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.

2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
4. Embedded continuous metallic strip or core.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.5 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 7 by 10 inches (180 by 250 mm).

C. Metal-Backed, Butyrate Warning Signs:

1. 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.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. 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)."

2.6 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background for equipment connected to normal power source, white letters on a red background for equipment connected to an emergency power source. Minimum letter height shall be 3/8 inch (10 mm).
- B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).
- C. Comply with NFPA 70E and Section 260573 "Coordination Study" requirements for arc-flash warning labels.

2.7 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 - 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. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
 - 5. Color: Black.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. In finished spaces, nameplates for panelboards shall be secured to the interior behind the door.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Attach signs and plastic labels with stainless screws.
- E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- F. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 8 inches (200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.
- H. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 20 A: Identify with snap-around label applied in bands. Install labels at 10-foot (3-m) maximum intervals.

- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
1. Emergency Power System - Yellow.
 2. Power - Orange.
 3. Fire Alarm System – Red.
 4. Security System – Blue and Yellow.
 5. Mechanical and Electrical Supervisory System – Green and Blue.
 6. Telecommunication Systems - Green and Yellow.
 7. Control Wiring – Green and Red.
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral: White.
 - 5) Ground: Green.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral: Gray.
 - 5) Ground: Green.
 - d. All control wiring shall be color-coded when using wires of different color from the type used to designate phase wires.
 - e. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

- E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 - 1. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs and metal-backed, butyrate warning signs.
 - 1. Comply with 29 CFR 1910.145.
 - 2. Identify system voltage with black letters on an orange background.
 - 3. Apply to exterior of door, cover, or other access.
 - 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- J. Operating Instruction Signs: 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.
- K. Emergency Operating Instruction Signs: 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.

- L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. For electrical equipment such as disconnect switches, motor starters, contactors, relays, pushbutton stations, etc., the label shall have the same designation as the equipment it serves. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

- a. Indoor Equipment: Engraved, laminated phenolic nameplates. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
- d. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated phenolic nameplate, “Panel (designation)”, “Served from “(designation)”.
- b. Enclosures and electrical cabinets.
- c. Access doors and panels for concealed electrical items.
- d. Switchboards.
- e. Transformers.
- f. Electrical rooms/closets.
- g. Emergency system boxes and enclosures.
- h. Motor-control centers.
- i. Enclosed switches.
- j. Enclosed circuit breakers.
- k. Enclosed controllers.
- l. Variable-speed controllers.
- m. Push-button stations.
- n. Power transfer equipment.
- o. Contactors.
- p. Remote-controlled switches, dimmer modules, and control devices.
- q. Power-generating units.
- r. Monitoring and control equipment.
- s. UPS equipment.

END OF SECTION

DIVISION 26 SECTION 26 05 73
SHORT CIRCUIT ANALYSIS, COORDINATION STUDY,
& ARC FLASH HAZARD ANALYSIS
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SECTION 26 05 73
SHORT CIRCUIT ANALYSIS, COORDINATION STUDY,
& ARC FLASH HAZARD ANALYSIS

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 SCOPE

- A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study. Electrical equipment shop drawings will not be reviewed/approved until the overcurrent protective device coordination study has been submitted.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in the current version of NFPA 70E – *Standard for Electrical Safety in the Workplace*. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584-2002, the IEEE *Guide for Performing Arc-Flash Calculations*. Arc-Flash Hazard Labels shall be provided for all electrical distribution equipment with level as determined by Study.

1.3 REFERENCES

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.
 - 2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
 - 3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
 - 4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.
 - 5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
 - 6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations.

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Power Circuit Breakers Rated on a Symmetrical Current Basis.
4. ANSI C37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA)

1. NFPA 70 – National Electrical Code, latest edition.
2. NFPA 70E – Standard for Electrical Safety in the Workplace.

1.4 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-study specialist.
- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form.
 1. Coordination-study input data, including completed computer program input data sheets.
 2. Study and Equipment Evaluation Reports.
 3. Coordination-Study Report.
 4. Arc Fault Hazards Evaluation.

1.5 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Engineering Analysis and Coordination Study performed by Coordinated Power Engineering, Inc., or a comparable product by one of the following:
 - 1. CGI CYME.
 - 2. EDSA Micro Corporation.
 - 3. ESA Inc.
 - 4. Operation Technology, Inc.
 - 5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device

settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Impedance of utility service entrance.
 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.

- b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
- c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
- d. Generator thermal-damage curve.
- e. Ratings, types, and settings of utility company's overcurrent protective devices.
- f. Special overcurrent protective device settings or types stipulated by utility company.
- g. Time-current-characteristic curves of devices indicated to be coordinated.
- h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system, determined from both the utility and paralleled generator sources. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 - 1. Switchboard bus.
 - 2. Distribution panelboard.
 - 3. Branch circuit panelboard.
 - 4. Automatic Transfer Switch.
 - 5. Uninterruptible Power Supply.
- B. Study electrical distribution system from normal power sources throughout electrical distribution system for Project.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141, and IEEE 242.
 - 1. Transformers:
 - a. IEEE C57.12.00.
 - b. IEEE C57.96.
 - 2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 - 3. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
 - 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
- F. Equipment Evaluation Report:
 - 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 - 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 - 2. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 141 and IEEE 242 recommendations for fault currents and time intervals.

- C. Transformer Primary Overcurrent Protective Devices:
1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.

- F. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC-FLASH HAZARD

- A. Perform Arc-Flash Hazard Analysis for each piece of distribution equipment and provide results indicating personnel protective equipment required for the potential hazard. Provide arc flash hazard labels as required by the NEC on each piece of equipment indicating the calculated arc-flash hazard.

3.6 ARC FLASH LABELS

- A. Contractor shall provide a 4.0 in. x 4.0 in. Brady thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. The labels shall be designed according to the following standards:
 - 1. UL969 – Standard for Marking and Labeling Systems
 - 2. ANSI Z535.4 – Product Safety Signs and Labels
 - 3. NFPA 70 (National Electrical Code) – Article 110.16
- C. The labels shall include the following information:
 - 1. System Voltage
 - 2. Flash Protection boundary
 - 3. Personal Protective Equipment category
 - 4. Arc Flash Incident energy value (cal/cm²)
 - 5. Limited, restricted, and prohibited Approach Boundaries
 - 6. Study report number and issue date
- D. Labels shall be printed by a thermal transfer type printer, with no field markings.
- E. Arc flash labels shall be provided for equipment as identified in the study and the respective equipment access areas per the following:
 - 1. Floor Standing Equipment – Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided on each individual section access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.

2. Wall Mounted Equipment – Labels shall be provided on the front cover of a nearby adjacent surface, depending upon equipment configuration.
 3. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.
- F. Labels shall be field installed by Contractor.

3.7 AVAILABLE FAULT CURRENT LABELING

- A. Contractor shall provide a 4.0 in. x 4.0 in. Brady thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. The labels shall include the following information:
 1. Line 1 – “Maximum Available Fault Current”
 2. Line 2 – “_____ Amperes”; Contractor shall field mark maximum available fault current available at the line terminals of the equipment.
 3. Line 3 – Date of Installation
- C. Labels shall be printed by a thermal transfer type printer.
- D. Labels shall be field-installed by the Contractor.

END OF SECTION

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DIVISION 26 SECTION 26 09 23
LIGHTING CONTROL DEVICES
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SECTION 26 09 23
LIGHTING CONTROL 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. Provide lighting controls that can operate as standalone local room network(s) and have the capability to expand to a central building wide network. The building wide network shall provide control, monitoring, adjustment and scheduling functionality. The system shall be PC based with software and historical data storage. The system shall support third party integration with the building management system through BACnet/IP.
- B. This Section includes the following lighting control devices:
 - 1. Time switches.
 - 2. Photoelectric switches.
 - 3. Daylight-harvesting controls.
 - 4. Indoor occupancy/vacancy sensors.
 - 5. Low voltage switches.
 - 6. Contactors.
 - 7. Emergency shunt relays.
- C. Related Sections include the following:
 - 1. Division 26 Section 262726, *Wiring Devices* for snap switches.
 - 2. Section 260943 “Network Lighting Controls”.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Coverage Plans: Provide full scale plans showing locations and coverage patterns for all occupancy/vacancy sensors.

- C. Location Plans: Provide full scale plans showing locations and coverage patterns for all devices.
- D. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
 - 2. Include diagrams for power, signal, and control wiring.
 - 3. Include riser diagrams showing all devices and wiring.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 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.

1.6 SUBSTITUTIONS

- A. The lighting control specification and lighting control details represent the basis of design. Acceptable manufacturers must meet the criteria listed in the system requirements as well as intent demonstrated through control details. Compliant systems are required to achieve the design intent and are not required to have all the parts and pieces listed.
- B. Manufacturers not listed in the list of Acceptable Manufacturers must submit for approval within 10 days prior to bid.
- C. Acceptable Manufacturers
 - 1. Basis of Design
 - a. Acuity Brand Controls; nLight.
 - 2. Alternative Manufacturers
 - a. Wattstopper; Digital Lighting Management
 - b. Hubbell NX
 - c. Eaton; Room Controller System

1.7 COORDINATION

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

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide a wired digital networked lighting control system as indicated on the drawings. The system shall include, but not be limited to, occupancy/vacancy sensor(s), photo sensor(s), digital room controller(s), digital switches, and all interconnecting wiring required for a complete operational system. The Basis-of-Design System is the Acuity Brand Controls; nLight.

2.2 TIME SWITCHES

- A. Basis-of-Design product: Subject to compliance with requirements, provide Acuity or a comparable product by one of the following:
 - 1. Wattstopper.
 - 2. Leviton Manufacturing Company, Inc.
 - 3. Pass & Seymour.
 - 4. Cooper Industries, Inc.
 - 5. Intermatic, Inc.
- B. Digital Time Switches: Wall switch style, electroluminescent back-lit LCD display shows timer countdown, time-out adjustments from 5 minutes to 12 hours, compatible with electronic ballasts; UL listed, five-year warranty.

2.3 OUTDOOR PHOTOELECTRIC SWITCHES

- A. 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. Acuity.
 - 2. Cooper Industries.
 - 3. Intermatic, Inc.
 - 4. NSi Industries, LLC; TORK Products.
 - 5. Tyco Electronics; ALR Brand.
- B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
3. Time Delay: 15-second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
5. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.4 CONTACTORS

- A. Basis of Design Product: Subject to compliance with requirements, provide ASCO; 918 series with solid-state control module for 2 wire control with number of poles and ratings as indicated on the drawing, or a comparable product by one of the following:
 1. Square D; Schneider Electric.
 2. Allen-Bradley/Rockwell Automation.
- B. Description: Electrically operated and mechanically held, combination type with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.
 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
- C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
 1. Monitoring: On-off status.
 2. Control: On-off operation.

2.5 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight nCm ADCX RJB or comparable product by one of the following:
 1. Wattstopper DLM

2. Hubbell NX
 3. Eaton
- B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 2. System programming is done with a hand held digital configuration tool or a PC with appropriate software.
 - a. Initial setup tool: a hand held digital configuration tool. Sensor adjustments may also be made using configuration pushbuttons on the sensors.
 - b. USB interface and PC software: capability to program, read, store, modify and document device and system configuration.
- C. Ceiling-Mounted Dimming Controls: Solid-state, digital light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye in order to automatically dim a lighting zone.
- D. Electrical Components, Devices, and Accessories:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operating Ambient Conditions: Dry interior conditions, 32 to 104 deg F (0 to 40 deg C).
 3. Sensor Output: Digitally communicates with room controller to dim loads based on lighting conditions. Sensor is powered from the room controller.
- E. Light-Level Sensor Set-Point Adjustment Range: 10 to 200 fc (108 to 2152 lux)
- F. Provide unit suitable for Low Temp/High Humidity environments in SHOPS and other unconditioned spaces.
- G. Provide single or dual zone control capability, as applicable.

2.6 INDOOR OCCUPANCY/VACANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight nCM PDT RJB, nWV PDT, or comparable product by one of the following:
1. Wattstopper DLM
 2. Hubbell NX

3. Eaton
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state digital indoor occupancy/vacancy sensors with a separate controller unit.
1. Systems programming is done with a hand held digital configuration tool or a PC with appropriate software.
 - a. Initial setup tool: a hand held digital configuration tool. Sensor adjustments may also be made using configuration pushbuttons on the sensors.
 - b. USB interface and PC software: capability to program, read, store, modify and document device and system configuration.
 2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. Operation:
 - a. Occupancy Sensor: Automatic-on when coverage area is occupied, and automatic-off when unoccupied.
 - b. Vacancy Sensor: Manual-on when coverage area is occupied, and automatic-off when unoccupied.
 - c. Time Delay for turning lights off adjustable over a minimum range of 1 to 30 minutes in 1-minute increments. Default setting: 20 minutes.
 4. Sensor Output: Digitally communicates with room controller to turn loads on and off based on occupancy. Sensor is powered from the room controller.
 5. Mounting:
 - a. Sensor: Suitable for mounting, ceiling mounting and corner mounting.
 - b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind removable cover.
 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
- C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
 2. Detection Coverage (Standard Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 3. Detection Coverage Large Room): Detect occupancy anywhere in a circular area of 2000 sq.ft. (186 sq.m) when mounted on a 96-inch-(2440-mm) high ceiling.

- D. Ultrasonic/Microphonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
 - 1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 - 2. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
- E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
 - 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 - 3. Detection Coverage (Corridor): Detect occupancy anywhere within 48 feet (18.0 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 12 feet (3.7 m).
 - 4. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 - 5. Detection Coverage (corner mount): Detect occupancy anywhere within a 30 foot (9145 mm) radius when corner mounted at ceiling or on wall at 120-inches (3058 mm) above the finished floor. Provide stem mount as required to maintain manufacturer's recommended mounting height.
 - 6. Detection Coverage (high bay): Detect occupancy anywhere within a 20 foot (6096 mm) radius when mounted at ceiling at 180-inches (4572 mm) above the finished floor. Provide stem mount as required to maintain manufacturer's recommended mounting height.

2.7 SWITCHBOX-MOUNTED LOW VOLTAGE OCCUPANCY/VACANCY SENSORS

- A. Subject to compliance with requirements, provide Sensor Switch nWSX-PDT-LV or nWSX-PDT-LV-DX (On/Off or Dimming to match function indicated on the drawings) or comparable product by one of the following:
 - 1. Wattstopper DLM

2. Hubbell NX
 3. Eaton
- B. General Description: Wall-mounting, solid-state units suitable for mounting in a single-gang switchbox.
1. Operation:
 - a. Occupancy Sensor Mode: Automatic-on when coverage area is occupied, and automatic-off when unoccupied.
 - b. Vacancy Sensor Mode: Manual-on when coverage area is occupied, and automatic-off when unoccupied.
 - c. Time Delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes in 1-minute increments. Default setting: 15 minutes.
 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
 3. Mounting:
 - a. Sensor: Suitable for mounting in a standard outlet box.
 - b. Time-Delay and Sensitivity Adjustments: Recessed and concealed.
 4. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 5. Bypass Switch: Override the on function in case of sensor failure.
- C. Dual-Technology Type: Wall mounting; detect occupancy by using a combination of PIR and ultrasonic or microphonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch (150 mm) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12-inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12-inches/s (305 mm/s).
 3. Detection Coverage: (Standard Room): Detect occupancy anywhere within a 15 foot radius (4572 mm) when wall mounted at 48-inches (1220 mm) above finished floor.

2.8 LOW VOLTAGE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight PODM, or comparable product by one of the following:
1. Wattstopper DLM

2. Hubbell NX
 3. Eaton
- B. General Description: Low-voltage, momentary pushbutton switches in 1, 2, 3, 4, 5, and 8 button configuration with the following features.
1. Two-way infrared (IR) transceiver for use with personal, and configuration remote controls.
 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 3. Configuration LED on each switch that blinks to indicate data transmission.
 4. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 5. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
- C. Two RJ-45 ports for connection to local network.
- D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology local network. No additional configuration will be required to achieve multi-way switching.
- E. The following switch attributes may be changed or selected using a wireless configuration tool:
1. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
 2. Individual button function may be configured to Toggle, On only, or Off only.
 3. Individual scenes may be locked to prevent unauthorized change.
 4. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 5. Ramp rate may be adjusted for each dimmer switch.
 6. Switch buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple loads.

2.9 DIGITAL ROOM CONTROLLERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight nPP16 or comparable product by one of the following:
1. Wattstopper DLM
 2. Hubbell NX
 3. Eaton
- B. Description: Self configuring, digitally addressable one, two or three relay controllers with 0-10 volt control for drivers and single relay application-specific plug load controllers (if applicable) Room controllers shall be provided to match room lighting load and control requirements and have the following features:
1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
 2. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.
 3. Device Status LEDs to indicate:
 - a. Data transmission.
 - b. Device has power.
 - c. Status for each load.
 - d. Configuration status.
 4. Quick installation features including:
 - a. Standard junction box mounting.
 - b. Quick low voltage connections using standard RJ-45 patch
 5. Plenum rated.
 6. Manual override and LED indication for each load.
 7. Dual voltage (120/277 VAC, 60 Hz)
 8. Zero cross circuitry for each load.
 9. Controllers shall be equipped for fail-safe operation and shall be evaluated for this purpose.
 10. Controllers shall be activated by activation of the building fire alarm system.
 11. Controllers shall be equipped for activation by the building security system.
- C. On/Off/Dimming enhanced room controllers shall include:

1. Real time current monitoring.
2. One, two or three relay configuration.
3. Efficient 250 mA switching power supply.
4. Four RJ-45 local network ports.
5. One 0-10 volt analog output per relay for control of compatible LED drivers.
6. Optional Network Bridge for BACnet MS/TP communications (LMRC-3xx).
7. The following dimming attributes may be changed or selected using a wireless configuration tool:
 - a. Establish preset level for each load from 0-100%.
 - b. Set high and low trim for each load.
 - c. Set lamp burn in time for each load up to 100 hours.
8. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
 - a. One relay configuration only.
 - b. Automatic-ON/OFF configuration.

2.10 CONFIGURATION TOOL

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight, or comparable products by one of the following:
 1. Wattstopper DLM
 2. Hubbell NX
 3. Eaton
- B. A configuration tool facilitates customization of local networks, and is used to set up open loop daylighting sensors. A wireless configuration tool features infrared communications, while PC software connects to each local network via a USB interface. Features and functionality of the wireless configuration tool shall include:
 1. Two-way infrared (IR) communication with IR-enabled devices within a range of approximately 30 feet.
 2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
 3. Read, modify and send parameters for occupancy sensors, daylighting sensors, room controllers and buttons on digital wall switches.

4. Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.
5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting.
6. Adjust or fine-tune daylighting settings established during auto-commissioning, and input light level data to complete commissioning of open loop daylighting controls.

2.11 EMERGENCY SHUNT RELAY

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Bodine or comparable product by one of the following:
 1. Lighting Control and Design, Inc.
 2. Nine Twenty Four.
- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 1008 and/or UL 924.
 1. Coil Rating: 120 / 277 V.

2.12 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section, Low-Voltage Electrical Power Conductors and Cables.
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 24 AWG. Comply with requirements in Division 26 Section 260519, *Low-Voltage Electrical Power Conductors and Cables*.
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section 260519, *Low-Voltage Electrical Power Conductors and Cables*."

PART 3 - EXECUTION

3.1 PRE-INSTALLATION MEETING

- A. Convene minimum two weeks prior to commencing Work of this section. Meeting to be attended by Contractor, Owner's representative, system installer, factory authorized manufacturer's representative, and representative of all trades related to the system installation.
- B. Review installation procedures and coordination required with related Work and the following:

1. Confirm the location and mounting of all devices, with special attention to placement of switches, dimmers, and any sensors.
 2. Review the specifications for low voltage control wiring and termination.
 3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
 4. Discuss requirements for integration with other trades.
- C. Inspect and make notes to job conditions prior to installation:
1. Record minutes of the conference and provide copies to all parties present.
 2. Identify all outstanding issues in writing designating the responsible party for follow-up action and the timetable for completion.
 3. Installation shall not begin until all outstanding issues are resolved to the satisfaction of the Owner's representative.

3.2 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section 260519, *Low-Voltage Electrical Power Conductors and Cables*. Minimum conduit size shall be 1/2 inch (13 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section 260553, *Electrical Identification*.
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work.
- C. Prepare test and inspection reports.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section 017900, *Demonstration and Training*.

END OF SECTION

DIVISON 26 SECTION 26 09 43
NETWORK LIGHTING CONTROLS
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SECTION 26 09 43
NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. The work covered in this section is subject to all of the requirements in the General Conditions of the Specifications. Contractor shall coordinate all of the work in this section with all of the trades covered in other sections of the specification to provide a complete and operable system. Provide all Labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section.

1.2 DESCRIPTION OF WORK

- A. Furnish and install a complete system for the control of lighting and other equipment as indicated on the plans, detailed in the manufacturer submittal, and as further defined herein. Contractor is solely responsible to verify quantity, installation locations and wiring requirements for this project. Specific manufacturer's catalog numbers, when listed in this section are for reference only. It is the responsibility of the contractor to verify with lighting control manufacturer all catalog information and specific product availability.
- B. The system shall include but not be limited to the following list: Pre-wired, microprocessor controlled relay or dimming panels with latching relays controlled via switches, photocells, occupancy sensors, time based control, building automation systems, thermostats, and other control devices.

1.3 SUBMITTALS

- A. Shop Drawings: Submit drawings of lighting control system and accessories including, but not necessarily limited to, relay panels, switches, occupancy sensors, photocells and other interfaces. Shop drawings shall indicate location of each device. Plans are diagrammatical. Electrical Contractor shall verify all lighting control material requirements from approved shop drawings. "Cut Sheet" submittal not acceptable.
- B. Product Data: Submit for approval manufacturer's data for each type of product. Include construction details, descriptions, dimensions, and conductors and cables. Submit a complete bill of materials with part numbers, description and voltage specifications.
- C. One Line Diagram: Submit a one-line diagram of the system configuration indicating the type, size and number of conductors between each component. Submittals that show typical riser diagrams are not acceptable.
 - 1. Show installation details for all devices including interconnection diagrams showing all field installed wiring.
 - 2. Include diagrams for power, signal and control wiring.

- D. Coverage Plans: Show locations and coverage patterns for all occupancy sensors.
- E. Programming Forms: Submit programming forms with complete information describing the operation of the network lighting control system and all other information necessary to show proper operation of the system.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

1.6 SUBSTITUTIONS

- A. The lighting control specification and lighting control details represent the basis of design. Acceptable manufacturers must meet the criteria listed in the system requirements as well as intent demonstrated through control details. Compliant systems are required to achieve the design intent.
- B. Manufacturers not listed in the list of Acceptable Manufacturers must submit for approval within ten (10) days prior to bid.
- C. Acceptable Manufacturers
 - 1. Basis of Design
 - a. Acuity Brand Controls; nLight.
 - 2. Alternative Manufacturers
 - a. Wattstopper; Digital Lighting Management.
 - b. Hubbell NX
 - c. Eaton; Room Controller System.

PART 2 - PRODUCTS

2.1 GENERAL SYSTEM REQUIREMENTS

- A. System Architecture
 - 1. System shall have an architecture that is based upon wired networkable intelligent lighting control devices, standalone lighting control zones using distributed intelligence, and system backbone for remote, time based and global operation between control zones.
 - 2. The system shall be capable of providing individually addressable switching and dimming control of the following: control zones to include multiple switch legs or circuits, relays and dimming outputs from centralized panels and networked

luminaires. System shall be capable of integrating indoor and outdoor lighting controls.

3. Lighting control zones shall be capable of being networked with a higher level system backbone to provide time based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through software.
4. System shall be capable of ‘out of box’ sequence of operation for each control zone. Standard Sequence is:
 - a. All switches control all power packs in a zone.
 - b. All occupancy sensors automatically control all power packs in the control zone with a default time out.

B. Wired Network Control Zone Characteristics

1. Following proper installation and provisions of power, all networked devices connected together with low voltage network cable shall automatically form a functional lighting control zone without requiring any type of programming. The ‘out of box’ default sequence of operation is intended to provide typical sequence of operation so as to minimize the system start up and programming requirements and to also have functional lighting control operation prior to system startup and programming.
2. System shall be able to automatically discover all connected devices without requiring any provisioning of system or zone address.

C. System Integration Capabilities

1. The system shall be capable of interface with third party building management systems to support two-way communication using the industry standard BACnet/IP or BACnet/MSTP protocols.

2.2 DISTRIBUTED SYSTEM POWER, SWITCHING AND DIMMING CONTROLS

- A. Devices shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output, and contribute low voltage class 2 power to the rest of the system.
- B. Device programming parameters shall be available and configurable remotely from the software and locally via the device push-button.
- C. Power packs shall accept 120 or 277 volt VAC and shall be plenum rated.
- D. Devices shall be UL listed for load and load types as specified on the plans.

2.3 WIRED NETWORK RELAY AND DIMMING PANEL

- A. Relays and dimming panels shall be capable of providing the required amount of relay capacity indicated as 4-relay, 8-relay, or 16-relay, as required per panel schedules shown on drawings, with an equal number of individually 0-10v dimming outputs.

- B. Standard relays used shall have the following required properties:
 - 1. Configurable in the field to operate with normally closed or normally open behavior.
 - 2. Provide visual status of current state and manual override control of each relay.
 - 3. Be individually programmable.
- C. 0-10 VDC dimming outputs shall support a minimum of 100 mA sink current per output.
- D. Panel shall be UL924 listed for control of emergency lighting circuits.
- E. Panel shall provide a contact closure input that acts as a panel override to activate the normally configured state of all relays in the panels.

2.4 WIRED NETWORKED WALL SWITCHES, DIMMERS, SCENE CONTROLLERS

- A. Wall switches & dimmers shall support the following device options:
 - 1. Number of control zones: 1, 2 or 4.
 - 2. Control Types Supported: On / Off or On / Off / Dimming.
- B. Scene controllers shall support the following device options:
 - 1. Number of Scenes: 1, 2 or 4.
 - 2. Control Types Supported:
 - a. On / Off or On / Off / Dimming
 - b. Preset Level Scene Type
 - c. Reprogrammed or other devices within daisy-chained zone so as to implement user selected lighting scene.
 - d. Selecting a lighting profile to be run by the system's upstream controller so as to implement a selected lighting profile across multiple zones.

2.5 WIRED NETWORKED OCCUPANCY AND PHOTOSENSORS

- A. Sensors shall utilize passive infrared (PIR) or dual technology (microphonic/ultrasonic plus passive infrared) to detect both the major (walking) and minor (hand) motion as defined by NEMA WD-7 standards.
- B. Sensing technologies that are acoustically passive, meaning they do not transmit sound waves to any frequency, do not require commissioning. Ultrasonic based sensing technologies may require commissioning or sensitivity adjustment due to the active nature of their technology, if factory required.
- C. Sensor coverage shall be coordinated with the floor plans. Sensors shall be available in standard and extended range, as well as being available with option for High Bay mounting.

- D. Sensor programming parameter shall be available and configurable remotely from the software and locally via the device.
- E. Sensor mounting type shall match project design requirements as shown on the plans.
 - 1. Sensors shall have optional features for photosensor/daylight override, dimming control and low temperature/high humidity operations.
- F. The system shall support the following types of photocell-based control:
 - 1. On / Off: The control zone is automatically turned off if the photocell reading exceeds the defined setpoint and automatically turned on if the photocell reading is below the defined setpoint. A time delay or adaptive setpoint adjustable behavior may be used to prevent the system from exhibiting nuisance on/off switching.
 - 2. Continuous Dimming: The control zone automatically adjusts its dimming output in response to photocell readings, such that a minimum light level consisting of both electric light and daylight sources is maintained at the task. The photocell response shall be configurable to adjust the photocell setpoint and dimming rates.

2.6 WIRED NETWORKED AUXILIARY INPUT / OUTPUT (I/O) DEVICES

- A. Auxiliary Input / Output Devices shall be specified as an input or output device with the following options:
 - 1. Contact closure input
 - a. Input shall be programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, ramp light level up or down, or toggle lights on/off.
 - 2. 0-10v analog input
 - a. Input shall be programmable to function as a daylight sensor.
 - 3. RS-232/RS-485 digital input
 - a. Input supports activation of up to 4 local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.
 - 4. 0-10v dimming control output, capable of sinking a minimum of 20 mA of current
 - a. Output shall be programmable to support all standard sequence of operations supported by system.

2.7 WIRED NETWORKED WALL SWITCH SENSORS

- A. Wall switches sensors shall support the following device options:

1. User input control types supported: On / Off or On / Off / Dimming.
2. Occupancy Sensing Technology: PIR or Dual Technology.
3. Daylight Sensing Option: Inhibit Photosensor.

2.8 SYSTEM CONTROLLER

- A. System Controller shall be a multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
- B. System Controller shall perform the following functions:
 1. Facilitation of global network communication between different areas and control zones.
 2. Time-Based control of downstream wired and wireless network device.
 3. Linking to an Ethernet network.
 4. Integration with Building Management System (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.
 5. Connection to various software interfaces, including management interface, historical database and analytics interface, visualization interface, and personal control applications.
- C. System Controller shall not require a dedicated PC or a dedicated cloud connection.
- D. Device shall automatically detect all networked devices connected to it, including those connected to wired and wireless communication bridges.
- E. Devices shall have a standard and astronomical internal time clock.
- F. Shall be capable of connecting to the customers Local Area Network (LAN) via IEEE 802.11.x Wireless and IEEE 802.3 wired connection.
- G. System Controllers shall support BACnet/IP and BACnet/MSTP protocols to directly interface with BMS and HVAC equipment without the need for additional protocol translation gateways.
 1. BACnet/MSTP shall support a minimum of 50 additional BACnet MS/TP controllers in addition to the expansion I/O modules.
 2. BACnet/MSTOP shall support 9600 to 115200 baud.
 3. System Controllers shall be BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building (B-BC) with outlined enhanced features.

4. System controllers must support BACnet/IP Broadcast Management Device (BBMS) and Foreign Device Registration (FDR).
- H. Controllers shall be equipped for fail safe operation and shall be evaluated for this purpose.
- I. Controllers shall be activated by activation of the building fire alarm system.
- J. Controllers shall be equipped for activation by the building security system.

2.9 SYSTEM SOFTWARE INTERFACES

A. Management Interface

1. System shall provide a web-based management interface that provides remote system control, live status monitoring, and configuration capabilities of lighting control settings and schedules.
2. Management interface must be compatible with industry-standard web browser clients.
3. All system software updates must be available for automatic download and installation via the internet.

B. Historical Database and Analytics Interface

1. System shall be capable of providing a browser-based trending and monitoring interface that stores historical data for all occupancy/daylight sensors and lighting loads. Additionally, the system shall optionally upload that data to a cloud based server.

C. Visualization Interfaces

1. System shall be capable of providing an optional web-based visualization interface that displays a graphical floorplan. System data, to include status of occupancy sensors, daylight sensors and light output shall be overlaid to the floorplan to provide a graphical status page.

D. Portable Programming Interface for Standalone Control Zones

1. System shall have option for a portable handheld application interface for standalone control zones.
2. Programming capabilities through the application shall include, but not be limited to, the following:
 - a. Switch/occupancy/photosensor group configuration.
 - b. Manual/automatic on modes.
 - c. Turn-on dim level.
 - d. Occupancy sensor time delays.
 - e. Dual technology occupancy sensors sensitivity.

- f. Photosensor calibration adjustment and auto-setpoint.
 - g. Trim level settings.
- E. Demand Response Client Interface
 - 1. System shall be capable of receiving a signal from the Utility or through a BAS control sequence and initiating load shed in response.
 - a. One full test of the Demand Response plan shall be performed and reports shall be included in the operations and maintenance manual.

PART 3 - EXECUTION

3.1 CONTRACTOR RESPONSIBILITY

- A. Contractor shall provide the proper quantities and types of sensors for complete coverage of the areas to be controlled.
- B. Contractor shall properly install, wire, test and adjust sensors according to manufacturer instructions.
- C. Contractor shall be responsible for a complete operational system as specified.
- D. Contractor shall warrant all equipment and installation for a period of two (2) years from date of substantial completion. Contractor shall make any necessary adjustments to the system at no charge to the Owner during the warranty period.
- E. Contractor/Regional Sales Manager shall provide training to the Owner's representative in the use, operation, adjustment and maintenance of the equipment.
- F. Contractor shall set the sensors time delays per owner's instruction.

3.2 SYSTEM START UP AND COMMISSIONING

- A. To facilitate start-up, all devices daisy-chained together shall automatically be grouped together into a functional lighting control zone.
- B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.
- C. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.
- D. All system devices shall be capable of being given user defined names.
- E. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.

- F. All sensor devices shall have the ability to detect improper communication wiring and blink it's LED in a specific cadence as to alert installation/startup personnel.

END OF SECTION

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LOW-VOLTAGE TRANSFORMERS
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SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

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 types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.
 - 2. Buck-boost transformers.
 - 3. Control power transformers.

1.3 SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Seismic Qualification Data: Certificates, for transformers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- 4. Certification: Indicate that equipment meets Project seismic requirements.
- D. Qualification Data: For Testing Agency.
- E. Source quality-control test reports.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- C. 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.
- D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
 - 1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.
- C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

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

1.6 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Manufacturers: Square D Co./Group Schneider NA; Schneider Electric. Subject to compliance with requirements, provide products by one of the following:
 - 1. Powersmiths.
 - 2. Siemens Energy & Automation, Inc.
 - 3. ABB-GE Electrification Equipment.
 - 4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
- B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Aluminum or Copper.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.
- E. Taps for Transformers Smaller Than 3 kVA: None.
- F. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.
- G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- I. Energy Efficiency: All transformers shall meet or exceed Department of Energy (DOE)) 2016 efficiency requirements per 110 C.F.R. &421/196 (2015).
- J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to K-factor of 13.
 2. Indicate value of K-factor on transformer nameplate
- K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 2. Include special terminal for grounding the shield.
 3. Shield Effectiveness:
 - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
 - b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
 - c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
- L. Wall Brackets: Manufacturer's standard brackets.
- M. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 BUCK-BOOST TRANSFORMERS

- A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.

B. Enclosure: Ventilated, NEMA 250, Type 2.

1. Finish Color: Gray.

2.5 CONTROL AND SIGNAL TRANSFORMERS

A. Units comply with NEMA ST 1 and are listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide capacity exceeding peak load by 50 percent minimum.

C. Description: Self-cooled, 2 windings.

2.6 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

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

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- C. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
 - 1. Visual and Mechanical Inspection.
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, and grounding.
 - c. Verify that resilient mounts are free and that any shipping brackets have been removed.

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

2. Electrical Tests:

- a. Measure resistance at each winding, tap, and bolted connection.
- b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
- c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
- d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

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

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

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

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

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PANELBOARDS
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**SECTION 26 24 16
PANELBOARDS**

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SUMMARY

- A. This Section includes distribution panelboards, lighting and power panelboards and fusible circuit breaker panelboards with associated auxiliary equipment rated 600 V and less.
- B. Related Sections include the following:
 - 1. Division 26 Section 264300, Surge Protection Devices.

1.3. SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 6. Include wiring diagrams for power, signal, and control wiring.
 - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
- C. Qualification Data: For qualified testing agency.

- D. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- F. Operation and Maintenance Data: For panelboards 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. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- G. Time current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.4. QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

1.5. 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. Keys: 2 spares of each type for panelboard cabinet lock.
2. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
3. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6. DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7. PROJECT CONDITIONS

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

1.8. COORDINATION

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

1.9. WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.10. ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

PART 2 - PRODUCTS

2.1. GENERAL REQUIREMENTS FOR PANELBOARDS AND LOAD CENTERS

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

- B. Enclosures: Flush- and surface-mounted cabinets. Piano hinged doors and covers.

1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 4X, stainless steel.
 - c. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X, stainless steel.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - f. Corrosive Locations: NEMA 250, Type 4X, polyester reinforced fiberglass.
 - g. Hazardous Areas: NEMA 250, Type 7.
2. Hinged Front Cover: Entire front trim piano hinged to box and with piano hinged door within hinged trim cover.
3. Skirt for Surface-Mounted Panelboards: Provide where indicated, same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
4. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Same finish as panels and trim.

5. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
 6. Multiple-Section Panelboards shall consist of two or more cabinets with identical interiors mounted under separate trims. Cabinets, trim, and doors shall be of the same size. Main lugs and busses of each section shall be rated as indicated on the Drawings. Where main breakers are indicated in multi-section panelboards, the main breaker shall be contained in one section with through-feed lugs and sub-feed cables installed within panel, equal to the incoming feeder size. All busses and lugs shall have ampere capacity equal to or greater than the main breaker ampere rating. Loads shall be divided as evenly as practical between the sections, in addition to being balanced over the phases.
- C. Incoming Mains Location: Top and bottom.
- D. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 3. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Main and Neutral Lugs: Compression type.
 3. Ground Lugs and Bus-Configured Terminators: Compression type.
 4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 6. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

- H. Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.
- I. Provide integral surge suppression device for each panel with SPD disconnect indicated in schedule on the drawings.

2.2. DISTRIBUTION PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
 - 1. ABB-GE Electrification Equipment
 - 2. Eaton Corp.; Cutler-Hammer.
 - 3. Siemens Energy & Automation, Inc.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Piano hinged doors and covers. Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inches (914 mm high, provide two latches, keyed alike.
- D. Mains: Circuit breaker or Lugs only, as indicated.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

2.3. LIGHTING AND APPLIANCE PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
 - 1. ABB-GE Electrification Equipment
 - 2. Eaton Corp.; Cutler-Hammer.
 - 3. Siemens Energy & Automation, Inc.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only, as indicated.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Piano hinged doors and covers. Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4. LOAD CENTERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
 - 1. ABB-GE Electrification Equipment
 - 2. Eaton Corp.; Cutler-Hammer.
 - 3. Siemens Energy & Automation, Inc.
- B. Load Centers: Comply with UL 67.
- C. Mains: Circuit breaker or lugs only, as scheduled.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.
- F. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.5. DISCONNECTION AND OVERCURRENT PROTECTIVE DEVICES

- B. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
 - 1. ABB-GE Electrification Equipment
 - 2. Eaton Corp.; Cutler-Hammer.
 - 3. Siemens Energy & Automation, Inc.
- G. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, 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 100A through 225A, field adjustable short-time and continuous current setting for frame sizes 250A and larger.
 - 2. GFCI Circuit Breakers: Single-and two-pole configurations with Class A ground-fault protection (6-mA trip).
 - 3. Ground Fault Equipment Protection (GFEP) Circuit Breakers; Class B Ground Fault Protection (30-mA trip).
 - 4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

- d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
- f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
- g. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
- h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
- i. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
- j. Handle Clamp: Loose attachment for holding circuit breaker handle in ON position for breakers serving clocks, telephone, and communications equipment, refrigerators, exit signs, fire alarm systems, controls, etc., to prevent accidental operation.

2.6. ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation per manufacturer's recommendations.
- B. Portable Test Set: Provide for testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

2.7. FUSIBLE DISTRIBUTION PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
 - 1. ABB-GE Electrification Equipment
 - 2. Eaton Corp.; Cutler-Hammer.
 - 3. Siemens Energy & Automation, Inc.
- B. Interior
 - 1. Shall be rated for 600 Vac or 250 Vdc. Continuous main current ratings are indicated on associated schedules, not to exceed 1200 amperes maximum. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67.
 - 2. Short circuit current ratings shall be provided as indicated on the associated schedules, not to exceed the lowest interrupting capacity rating, at the supply voltage of any fusible switch installed with a maximum of 200,000 rms symmetrical amperes at 600 Vac. Main switch and main lug panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230.VI and VII

3. The panelboard bus material shall be plated copper. Bus bar plating shall run the entire length of the bus bar. The bussing shall be fully rated allowing high ampacity switches to be mounted in any position throughout the interior.
4. Main lugs and solid neutral shall be mounted in the mains compartment. Main lugs compartment shall be isolated by a bolted cover to shield user from energized parts. Branch mounted main lug kits will not be acceptable. Main lugs or main switch interiors shall be field convertible for top or bottom incoming feed.
5. A solidly bonded copper equipment ground bar shall be provided.
6. Solid neutral shall be equipped with a full capacity bonding strap for service entrance applications. Gutter mounted solid neutral will not be acceptable.
7. Nameplates shall contain system information and catalog number or factory order number.

C. Fusible Switches

1. The operating mechanism shall be spring driven, with quick-make, quick-break action. Operating handles shall be flange mounted, as an integral part in the operating mechanism. Switch contact shall be knife-blade and jaw construction. Switch shall include visible blades as a visual verification of blade position. There shall be a visible air gap between the switch jaws and the knife-blade with the switch in the OFF (open) position.
2. Switches shall be secured to the bus with spring reinforced jaw assemblies.
3. Fusible switch units shall be equipped with all required mounting brackets and guides.
4. Switch shall have dual mechanical cover interlocks to prevent the opening of the cover when the switch is in the ON position. The cover interlock shall also prevent the switch from being turned ON with the cover open. A manual interlock override shall be provided for testing purposes. Switch cover shall include a hasp by which the cover can be padlocked in the closed position. The operating handle shall have lock-off means with provisions for three (3) .375-inch padlocks.
5. There shall be two forms of visible ON/OFF indication: A dual-color operating handle and an ON/OFF nameplate with international markings. The universal nameplate shall be readable regardless of the switch orientation. Each nameplate shall include an easily removable circuit directory card.
6. Switch fuse clips shall accept [Class R] [Class J] [Class H] fuses through 600 amperes and Class L from 601 amperes through 800 amperes. Fusible switches shall have built-in fuse pullers on 30 through 100 ampere switches as standard construction. Fuse pullers shall disengage the line side of fuse only.
7. Fusible switches shall accept the following UL Listed field installable accessories: Compression lugs, Copper mechanical lugs, and Electrical interlocks.

D. Enclosures

1. Type 1 Boxes

- a. Boxes shall be hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements. Unpainted galvanized steel is not acceptable.
- b. Boxes shall have removable blank endwalls and interior mounting studs. Zinc-coated galvanized steel will not be acceptable.
- c. Maximum enclosure shall not exceed 38" wide and 18" deep.

2. Type 1 Trim Fronts

- a. Front shall meet strength and rigidity requirements per UL 50 standards. Front shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
- b. Front shall be standard 4-piece surface. Optional door shall have rounded corners and edges free of burrs. A clear plastic directory card holder shall be mounted on the inside of the door.
- c. Trim front with door shall have cylindrical tumbler type lock. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock.

3. Type 3R, 5, and 12

- a. Enclosures shall be constructed in accordance with UL 50 requirements. Endwalls shall be welded and sealed. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
- b. All doors shall be gasketed and be equipped with a tumbler type vault lock and two (2) additional quarter turn fasteners. A clear plastic directory card-holder shall be mounted on the inside of door. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock.
- c. Maximum enclosure dimensions shall not exceed 39" wide and 14.95" deep.

2.8. FUSIBLE BRANCH CIRCUIT PANELBOARDS

- A. Basis of Design Product: Combination circuit breaker and fusible branch circuit panelboards shall be Mersen Fused Coordination Panelboard type MFCP or approved equal.

B. Panelboard Ratings

1. Panelboards shall be labeled with a short-circuit current rating (SCCR) equal to or greater than that indicated on the associated schedules or drawings.
2. Non-service and service entrance rated panelboards shall be UL listed.
3. Panelboards shall be rated 600Vac and have a current rating as indicated on the associated schedules or drawings.
4. Panelboard overcurrent protective device interrupting ratings shall be UL listed and rated for the maximum available fault current.

5. Current ratings, configuration of poles and number of circuits shall be indicated on associated schedules or drawings. Mersen Fused Coordination Panelboard Specifications.

C. Construction

1. Panelboard branch circuits shall incorporate overcurrent protection using fuse types that are manufactured by at least three independent companies to assure replacement availability.
2. Interiors shall be factory assembled.
3. Bus bars shall be tin-plated copper with sufficient cross sectional area to meet UL 67 temperature rise requirements.
4. 200 ampere rated neutral shall be standard, 400 ampere rated neutral shall be provided where indicated in the associated schedules or drawings.
5. Bonded neutral shall be provided where specified in associated drawings.
6. Isolated or non-isolated equipment ground bar shall be provided as indicated in the associated schedules or drawings.
7. Where a service-entrance rated panelboard is indicated in associated schedules or drawings, a bonded neutral and non-isolated equipment ground bar shall be provided by the manufacturer.
8. Main lug conductor terminations:
 - a. MLO terminations shall be rated for 60/75°C, Cu-Al
 - b. Main disconnect terminations shall be rated for 75°C, Cu Only
9. Where specified on drawings, NEMA 1 and NEMA 3R panelboards shall be for top or bottom incoming feed.
10. Where specified on drawings and specifications, the panelboards shall meet seismic zone ratings based upon third party testing.

D. Main Disconnect

1. Where specified in the drawings, permanently installed lockout means shall be provided on the main disconnect for lock out tagout (LOTO) procedures.
2. Main disconnect shall be quick-make, quick-break type.

E. Branch Circuit Overcurrent Protection

1. Both circuit breaker and fuse shall have visible circuit ON/OFF indication.
2. Fuse holder shall provide open fuse indication via permanently installed neon indicating light where included in the plans and specifications.
3. Overcurrent protective devices shall be UL Listed, with voltage and short-circuit current ratings meeting the available voltage and short current shown on the drawings. The combination circuit breaker and fuse shall have amperage ratings and number of poles as indicated on the panelboard schedule.
4. Circuit breakers and fuses shall be finger-safe components with trim installed.
5. Fuse holder shall be designed so as not to allow fuse removal while fuse terminals are energized.
6. No special tools shall be required for fuse removal.
7. breakers and fuses shall be clearly marked with device amperage.
8. Circuit breakers and fuses shall be clearly marked with device amperage.

9. Branch overcurrent protective devices shall minimize the types and rating of fuses to only 30A, 60A and 100A for simple maintenance.
10. Branch circuit load terminations shall be UL listed for one and two wires per terminal.
11. Multipole branch circuit overcurrent protection devices shall trip on an overcurrent of any pole to prevent single-phasing of the load.
12. Branch circuit overcurrent protection devices shall be “Bolt In.”
13. Branch circuit overcurrent protection devices shall be resettable without replacing fuses for overcurrents for at least twice their rating.
14. Short circuits shall be cleared within ½ cycle to prevent sensitive equipment disruptions.

F. Main and Branch Overcurrent Protection

1. All fuse protective devices shall have a minimum interrupting rating of 200kA.
2. Branch circuit overcurrent protection shall be UL Listed for the voltages specified on the drawings.
3. Main overcurrent protective devices shall be UL Listed for the voltages specified on the drawings.

G. Enclosure

1. NEMA 1 enclosures shall be surface or flush mount as indicated in associated schedules or drawings. NEMA 3R enclosures shall be surface mount only.
2. Boxes with 60A and less branch circuits shall be a nominal 20 inches wide and 6 inches deep with wire bending space per the National Electrical Code®.
3. Panelboard trim shall be supplied with lockable door covering all circuit breaker and disconnect handles.
4. Panelboard trim shall be dead-front construction covering all energized parts.
5. Enclosures shall be NEMA Type 1 or Type 3R as indicated in associated schedules or drawings.
6. Door-in-door type trim shall be provided for NEMA 1 enclosures where it is specified in the associated schedules or drawings.
7. Front trim shall be lockable. All lock assemblies shall be keyed alike.
8. Surge Protection shall be internally installed as indicated in associated schedules and drawings.

- H. Provide 20% or minimum of three fuses of each rating and type of fuse installed, in a spare fuse cabinet mounted in the same room(s) as the fusible panelboard(s).

PART 3 - EXECUTION

3.1. EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- D. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- E. Install filler plates in unused spaces.
- F. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- H. Comply with NECA 1.
- I. Air distribution panels shall be installed on galvanized formed steel channels designed to distribute the weight on the supporting wall.
- J. Conduits entering the tops and bottoms of flush panels shall be located back from the front ledge of the panels to allow approximately 2-inches between the finished wall and the edge of the conduits.
- K. Where panelboard is mounted flush in a wall or partition, provide 3/4-inch empty conduit, from panelboard to ceiling space for each three or less spare single pole breakers and/or spaces in the panel unless otherwise noted on the drawings.
- L. Surge protective device units shall be installed immediately above or below panelboard enclosure, per manufacturer's recommendations, connected to circuit breaker disconnecting means with lead length of conductors less than 18 inches.

3.3. IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4. FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5. ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour

services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
5. Set field-adjustable circuit-breaker trip ranges as specified in Section 260.

3.6. PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

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SECTION 26 27 16
COMMERCIAL PEDESTALS

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. SCOPE

- A. Section includes pad-mounted, weatherproof electrical enclosures with custom configurations of electrical equipment including but not limited to circuit breakers, transformers, load centers, photocells, etc.
- B. Provide all labor, materials, equipment, and services necessary to provide commercial pedestals as indicated herein and on the Contract Drawings.

1.3. RELATED WORK

- A. Division 26 Section 26050, “Common Work Results for Electrical”, for requirements for concrete equipment pads for commercial pedestals.
- B. Division 25 Section 260526, “Grounding and Bonding for Electrical Systems”, for grounding and bonding materials.
- C. Division 26 Section 260543, “Underground Ducts and Raceways for Electrical Systems”, for ductbanks serving commercial pedestals.
- D. Division 26 Section 262726, “Wiring Devices”, for requirements for wiring devices in commercial pedestals.

1.4. QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firm experienced in manufacturing utility structures of types and sizes required and similar to those indicated for this Project. Firm must have a minimum of a 3-year record of successful in-service performance.
- B. Comply with NFPA 70: Electrical Code and ANSI C2 National Electrical Safety Code for components and installation.
- C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms Listed and Labeled: As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications; A Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

- D. Coordinate layout and installation of pedestals with final arrangement of other utilities as determined in the field.
- E. Coordinate elevations of ductbank entrances into pedestals with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions.

1.5. SUBMITTALS

- A. Submit shop drawings and product data under provisions of General Conditions of the Contract and Division 26.
- B. Indicate material specifications, dimensions, capacities, size and location of openings, reinforcing details, and accessory locations.
- C. Provide product data for pedestal type, and accessories.
- D. Submit Shop Drawings, including the following:
 - 1. Drawings for each commercial service pedestal configuration.
- E. Submit manufacturer's installation instructions under provisions of General Conditions of the Contract.
- F. Qualification data for firms and persons specified in Quality Assurance Article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Architect and Owner, and other information specified.
- G. Field test reports indicating and interpreting test results relative to compliance with performance requirements of Field Quality Control Article in Part 3 of this Section.

1.6. PROJECT RECORD DOCUMENTS

- A. Submit under provisions Division 26 Section 260500, "Common Work Results for Electrical".
- B. Accurately record actual locations of each pedestal.

1.7. DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Division 26 Section 260500, "Common Work Results for Electrical".
- B. Accept products on site. Inspect for damage.
- C. Lift and support units only at designated lifting or supporting points.

1.8. COORDINATION

- A. Obtain all available information on underground utilities before starting excavation. If underground utilities interfere with shown location of pedestals, bring this to the attention of the Engineer as soon as possible. Pedestal locations shall be revised or relocated only with the approval of the Architect and Engineer.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering the specified products that may be incorporated in the work include, but are not limited to, the following:
 - 1. Commercial Pedestals:
 - a. Milbank Manufacturing (Basis of Design)
 - b. Myers Pedestals
 - c. Tesco Controls, Inc.
 - d. VIT Products

2.2. COMMERCIAL PEDESTALS

- A. Description: Pad-mounted, weatherproof electrical enclosures for site power distribution.
- B. Construction:
 - 1. External construction shall comply with UL50 requirements and shall be of G90 galvanized steel with Federal Specification 595 polyurethane industrial grade powder paint of 1.7 mil minimum thickness, unless otherwise indicated.
 - 2. Internal construction shall be G90 galvanized steel and 1.7 mil minimum thickness polyurethane industrial grade powder coat painted. No fasteners except sealing screws shall be removable by external access. Hinges shall be stainless steel and of the continuous piano hinge type.
- C. Mounting: The pedestal mounting bolts shall not be externally accessible. The pedestal shall be offered with an optional base designed to be embedded in concrete in place of anchor bolts. Either pedestal mounting base or anchor bolt kit is required for installation.
- D. Features:
 - 1. Compartment door to be hinged on the left-hand side.
 - 2. A stainless steel pad-lockable hasp provided to secure compartment.
 - 3. A door keeper provided to keep the door in an open position.
 - 4. A print pocket on the inside of the door shall hold all wiring schematics, circuit

directories and instructions in a clear, weatherproof sleeve.

5. Required UL labeling shall be located on the inside of the compartment door.
 6. All stainless steel external hardware (screws, bolts, hinges, handles, hasps, and sealing screws).
 7. Distribution and control equipment shall be behind an internal dead-front door with a quarter-turn securing latch and be hinged to open more than 90 degrees.
 8. The dead-front door shall be hinged on the same side as the compartment door.
 9. All distribution and control equipment shall be factory wired using 600 volt wire sized to NEC and UL requirements.
- E. Electrical: Pedestals shall contain molded-case circuit breakers, panelboards, sealed transformers, and/or lighting control devices as indicated on the Contract Drawings. See Contract Drawings for additional information.
1. Circuit breakers shall comply with requirements of Division 26 Section 262816, “Enclosed Switches & Circuit Breakers”.
- F. Ratings: The service pedestal shall be rated for operation at 10K minimum (AIC) amps interrupting capacity. The provided documentation shall list circuit breaker combinations and those to be used for de-rated operation for series ratings. Circuit breakers shall be permanently labeled with engraved name plates.
- G. Finish: Architect/Owner shall select finish from standard factory finish options.
- H. Listings: Pedestals shall be of NEMA Type 3R rainproof construction and shall be UL listed as “Enclosed Industrial Control Equipment”.

PART 3 - EXECUTION

3.1. EXCAVATION

- A. Provide responsibility for all demolition, excavation and backfilling required to install foundations for commercial pedestals.
- B. After completion of pedestal installation, return all ground and pavement surfaces to original condition or to condition as indicated on the drawings. This includes all sidewalks, curbs, streets, parking areas, lawns, shrubs, etc.

3.2. PREPARATION

- A. Excavate, install base material, and compact base material.

3.3. INSTALLATION

- A. Identify pedestals according to Division 26 Section 260533, “Identification for Electrical Systems”.

- 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. Install pedestals as indicated on the Drawings, in accordance with Manufacturer's published instructions.
- D. Provide working clearances in conformance with NFPA 70.
- E. Provide minimum 6-inch high concrete pad for outdoor pedestals. Refer to Division 26 Section 260500, "Common Work Results for Electrical", for installation requirements. Use manufacturer-approved mounting brackets for securing pedestals to concrete equipment pads.
- F. Set pedestals plumb and level.
- G. Seal conduits turning up into pedestals with foam duct sealant specified in Division 26 Section 260500, "Common Work Results for Electrical".

3.4. GROUNDING

- A. Comply with Division 26 Section 260526, "Grounding and Bonding for Electrical Systems", for materials and installation requirements.
- B. Provide ground rod(s) for each pedestal as detailed on the Contract Drawings.
- C. Ground and bond separately derived systems (i.e. transformers) per National Electrical Code Article 250.30. Provide supply-side bonding jumper from transformer to first disconnecting means or overcurrent device after the transformer.

3.5. FIELD QUALITY CONTROL

- A. Visual and Mechanical Inspection:
 - 1. Inspect for defects and physical damage, labeling, and compliance with requirements of drawings and schedules.
 - 2. Clean pedestals using Manufacturer's approved methods and materials.
 - 3. Verify that equipment nameplates are installed and accurate.
 - 4. Verify that phase identification nameplates are installed.
 - 5. Verify that arc flash hazard labels are installed.
 - 6. Check mounting, area clearances, and alignment and fit of components.
 - 7. Check tightness of bolted electrical connections with calibrated torque wrench.
 - 8. Refer to manufacturer's instructions for proper torque values.

9. Verify that neutral bar is bonded to ground bar with appropriately sized bonding jumper.
 10. Verify that equipment ground bar is bonded to pedestal enclosure.
 11. Test Labeling: On satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.
- B. Electrical Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
1. Testing Agency: Provide services of a qualified independent testing agency to perform specified testing. Provide set of Contract Documents to test organization. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in the original Contract Documents.
 2. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.
 3. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A and UL 486B.
 4. Protective Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system configuration and parameters. Where discrepancies are found, recommend final protective device ratings and settings. Use accepted ratings or settings to make the final system adjustments.
 5. Make continuity tests of each circuit. Refer to Division 26 Section 260519, "Low-Voltage Electrical Power Conductors and Cables" for testing specific to feeder conductors.
 6. Perform ground resistance test on system and equipment ground connections
 7. Test main and branch over-current protective devices.
 8. Infrared Scanning: Perform an infrared scan of all electrical connections in each pedestal, as follows:
 - a. Remove equipment covers so terminations are accessible to scanner.
 - b. Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values.
 - c. Provide calibration record for device.
 - d. Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest.
 - e. Prepare reports certified by testing agency identifying equipment checked and describing results of tests. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

9. Test Labeling: On satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.
10. Submit all test reports to the Architect for review and approval.
11. Provide copy of all test reports in the O&M manual.

3.6. CLEANING

- A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.
- B. Remove debris from pedestals and ensure complete installation is left in neat and finished condition.

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WIRING DEVICES
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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. Hazardous (classified) location receptacles
 - 3. Twist-locking receptacles.
 - 4. Pendant cord-connector devices.
 - 5. Cord and plug sets.
 - 6. Toggle switches.
 - 7. Wall plates.
 - 8. Emergency pushbuttons.
 - 9. Protective wire guards.
 - 10. Tele/power poles
 - 11. Poke-thru assemblies.
- B. Related sections include the following:
 - 1. Section 260923 – Lighting Control Devices.

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.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Field quality-control test reports.
- D. 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.

1.6 COORDINATION

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements manufacturers offering products that may be incorporated into the work include, but are not limited to, the following available manufacturers' names:
 - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, Tamper-Resistant 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; BR20*.
 - b. Leviton; 5362-SG*.
 - c. Pass & Seymour; TR5262*.

2.3 GFCI RECEPTACLES

A. General Description:

1. Straight blade, non-feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. GFCI Convenience Receptacles, Tamper-Resistant 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; GFTR20.
 - b. Pass & Seymour; 2095TR.
2. Receptacle(s) shall also be weather-resistant type for exterior applications.

2.4 ISOLATED-GROUND RECEPTACLES

- ### A. Description: Straight blade; equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts. Two pole, three wire, and self-grounding.
1. Configuration: NEMA WD 6, Configuration 5-20R.
 2. Standards: Comply with UL 498 and FS W-C-596.
 3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 - b. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - c. Leviton Mfg. Company Inc. (Leviton).
 - d. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.5 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

- A. Available Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1203.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper Crouse-Hinds.
 - b. EGS/Appleton Electric.
 - c. Killark; a division of Hubbell Inc.
 2. Description: Straight blade receptacle with matching connector, unless otherwise noted.
 3. Class I, unless otherwise noted.
 - a. Division: 2, unless otherwise noted.
 4. Raintight.

2.6 TWIST-LOCKING RECEPTACLES

- A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; L520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass & Seymour; L520-R.

2.7 PENDANT CORD-CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade, or as noted on the Drawings.
1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.8 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.9 TOGGLE SWITCHES

A. Comply with NEMA WD 1 and UL 20.

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

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Lighted Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hubbell HBL1221ILC (single pole) or approved equal.
2. Description: Handle illuminated when switch is off.
3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

D. Pilot Light Switches, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 2221PL for 120 V and 277 V.
 - b. Hubbell; HPL1221PL for 120 V and 277 V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
 - d. Pass & Seymour; PS20AC1-PLR for 120 V.
2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

E. Key-Operated Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 2221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
 2. Description: Single pole, with factory-supplied key in lieu of switch handle.
- F. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Wattstopper; LVS-1.
 - b. Cooper; 1995.
 - c. Hubbell; HBL1557.
 - d. Leviton; 1257.
 - e. Pass & Seymour; 1251.
- G. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Wattstopper; LVS-1K-G.
 - b. Cooper; 1995L.
 - c. Hubbell; HBL1557L.
 - d. Leviton; 1257L.
 - e. Pass & Seymour; 1251L.

2.10 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. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting.
 3. Material for Shop Areas: 0.035-inch- (1-mm-) thick, satin-finished stainless steel.
 4. Material for Unfinished Spaces: Galvanized steel.
 5. Color: Matches wiring device, except as otherwise indicated.
 6. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in "wet locations."
- B. Material for Damp Locations: Heavy-duty die-cast zinc/aluminum construction listed and labeled for use in "wet locations." All components shall have baked-on electrostatic,

polyester, power paint finish for superior corrosion resistance. Covers for receptacles shall be equipped with one or more lift cover(s) equipped with stainless steel springs. Covers for toggle switches shall be equipped with actuating levers and shall mount directly over the switch.

1. Duplex Receptacle, 2 Self-Closing Lids – Pass & Seymour Model No. CA8GH (Horizontal) or approved equal.
 2. GFCI Receptacle, 1 Self-Closing Lid – Pass & Seymour Model No. CA26GH (Horizontal) and Pass & Seymour Model No. CA26GV (Vertical), or approved equal.
 3. Toggle Switch – Pass & Seymour Model No. CA1GL or approved equal.
 4. Toggle switch, lockable cover – Crouse-Hinds Model No. DS185, or approved equal.
- C. Material for Wet Locations: Heavy-duty die-cast zinc/aluminum construction with gasketed, hinged lockable lid, designed to be weatherproof while the device is in use, and listed and labeled for use in “wet locations.” All components shall have baked-on electrostatic, polyester, power paint finish for superior corrosion resistance. Covers for receptacles shall be self-closing per UL514C42.3, be equipped with stainless steel springs, and shall have a cam action latch for secure closure. Covers for toggle switches shall be equipped with actuating levers and shall mount directly over the switch.
1. Duplex/GFCI Receptacle - Pass & Seymour Model No. WIUCAST1 or approved equal.
 2. Toggle switch – Pass & Seymour Model No. CA1GL, or approved equal.
 3. Toggle switch, lockable cover – Crouse-Hinds Model No. DS185, or approved equal.
- D. Provide jumbo size plates for outlets installed in masonry walls.

2.11 RETRACTABLE CORD REEL WITH DUPLEX OUTLET BOX AND GFCI PROTECTION

- A. Description: Factory-fabricated retractable cord reel with DUPLEX receptacle outlets and the following features:
1. Cord: Type “SJEOOW” with (3) #12 AWG conductors, 45 foot length.
 2. Receptacle outlet: Nylon body with three (3) NEMA S-15R grounded receptacles.
 3. Integral GFCI protector on word.
 4. Steel frame and steel reel sides.
 5. Factory-assembled, modular type collector ring and brush block assembly.

6. Lifetime lubricated bearings.
 7. Removable cover(s) for access to springs and ring/brush assembly.
 8. Adjustable, four-roller cord outlet guide.
 9. Built-in cord locking ratchet to hold cord at desired length. Ratchet can be disengaged to provide constant cord tension.
- B. Basis of Design: Hubbell HBL45123GF20Y. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Reelcraft L4545
 2. Cooper Crouse-Hinds.
 3. EGS/Appleton Electric.

2.12 EMERGENCY PUSHBUTTONS

- A. General:
1. Emergency pushbuttons shall be Stopper Station with Bopper Stopper cover, as manufactured by Safety Technology International, Inc. (STI), or approved equal.
- B. Features:
1. Button activation shall be Push-to-Activate, Turn-to-Reset.
 2. Interchangeable or replaceable Normally Open (N.O.) or Normally Closed (N.C.), Single-Pole, Single-Throw (SPST) gold-plated contact blocks rated for three (3) amps at 600 VAC or one (1) amp at 250VDC.
 3. Standard switch shall include one N.O. and one N.C. contact.
 4. Switch shall hold up to three (3) sets of isolated contacts.
- C. Construction:
1. Housing shall be molded of polycarbonate rated for temperature range of -40 degrees to 250 degrees Fahrenheit.
 2. Housing color shall be yellow, unless otherwise indicated.
 3. Pushbutton shall be provided with stainless steel backplate and matching polycarbonate spacer (as required), both having a 5VA flammability rating.
- D. Labeling:

1. Pushbuttons shall be provided with a vinyl label that is customized to suit each application, including, but not limited to the following:
 - a. “Emergency Power Off”
 - b. “Water Heater Shut-Down”
 - c. “Emergency Utilities Off” (used when shutting off multiple utilities, i.e. power, air, water, and/or gas)

E. Cover

1. Pushbutton covers shall have the following features:
 - a. Molded from thick clear polycarbonate material.
 - b. UV stabilized.
 - c. 94V-2 flammability rating.
 - d. Stainless steel torsion spring to maintain cover in a closed position.
 - e. Mounting hardware and gasket.
 - f. Lifetime guarantee against breakage of polycarbonate from normal use.

F. Quality Assurance

1. Pushbuttons shall be tested and approved or listed by:
 - a. Underwriter Laboratories (UL) and Canadian Underwriter Laboratories No. S7255.
 - b. Complies with UL 2017.
 - c. UL listed for indoor and outdoor use, when used with appropriate weather cover.
2. Pushbuttons shall be ADA Compliant.

G. Warranty

1. Pushbuttons shall be provided with lifetime guarantee against breakage of polycarbonate in normal use.
2. Pushbuttons shall be provided with one year guarantee on electro-mechanical and electronic components.

2.13 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
1. Wiring Devices: White, or as specified by architect, unless otherwise indicated or required by NFPA 70 or device listing.
 2. Wiring Devices Connected to Emergency Power System, including legally required standby and optional standby: Red.
 3. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

2.14 PROTECTIVE WIRE GUARDS

- A. Provide protective wireguards over devices subject to physical damage. All devices installed in the gymnasium, in mechanical and electrical rooms, in shop classrooms and on the exterior of the building shall be provided with protective guards. Protective guards shall be manufacturer's recommended product for the device being protected or a suitable guard as manufactured by American Time & Signal Company (800-328-8996), Safety Technology International (STI) (800-888-4784), or Institutional Systems Services Corporation (800-524-0537).
- B. Devices to be provided with protective guards include, but are not limited to, the following:
 - 1. Lighting Fixtures
 - 2. Clocks
 - 3. Bells
 - 4. Fire Alarm Pull Stations
 - 5. Thermostats
 - 6. Smoke/Heat Detectors
 - 7. Speakers
 - 8. Fire Alarm Audio/Visual Devices (Strobe, Horn, etc...)
 - 9. Exit Signs
 - 10. Emergency Lights
 - 11. Telephones
 - 12. Data Outlets
 - 13. Security Devices/Motion Detectors
 - 14. Wiring Devices
 - 15. Emergency Shut-Off Stations
 - 16. Other Devices as required by Owner
- C. Guard shall be fabricated from ¼-inch (9-gauge) cold-rolled steel rods, welded together with mounting tabs. Guard shall be finished with a powder-based epoxy to protect against corrosion. Finish color shall match the finishes for the area being installed, except guards for fire alarm devices shall be red finish color.

- D. Protective Devices shall be considered incidental to the product installed in an area subject to damage as indicated on the drawings and shall be provided at no additional cost to the Owner.

2.15 TELE/POWER POLES

A. Dual-Channel Tele/power Poles

1. Basis of Design: Legrand. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hubbell.
2. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
3. Poles: cross-section area as required for back to back device mounting as detailed, with height adequate to extend from floor to at least 6 inches (150 mm) above ceiling, and with separate channels for power wiring and voice and data communication cabling.
4. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
5. Material: Aluminum.
6. Finishes: Satin-anodized aluminum.
7. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, balanced twisted pair data communication cables.
8. Power Receptacles: Two duplex, 20-A, straight-blade receptacles per side complying with requirements in this Section.
9. Data Communication Outlets: Blank insert with bushed cable opening per side.

2.16 POKE-THROUGH ASSEMBLIES

- A. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
- B. Basis of Design: Legrand. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Hubbell.
- C. Standards: Comply with scrub water exclusion requirements in UL 514.

- D. Service-Outlet Assembly: Flush type with four simplex receptacles as detailed.
- E. Size: Selected to fit nominal 4-inch (100-mm) cored holes in floor and matched to floor thickness.
- F. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
- G. Closure Plug: Arranged to close unused 4-inch (100-mm) cored openings and reestablish fire rating of floor.
- H. Wiring Raceways and Compartments: For a minimum of eight No. 12 AWG conductors.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
 - 1. Take steps to ensure 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.
- C. 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.
- D. 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. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 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.
- E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
- 3.2 GFCI RECEPTACLES
- A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.
- 3.3 IDENTIFICATION
- A. Comply with Division 16 Section "Identification for Electrical Systems."
1. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate. Light

switches shall be labeled as to lights controlled and with circuit number and panel identification.

2. Receptacles: Identify panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate and durable wire markers or tags within outlet boxes. Protect label from damage during construction. Replace all damaged and unclear labels.
3. Mark all conductors with the panel and circuit number serving the device at the device.
4. Mark the panel and circuit number serving the device on the back side of the device plate with a permanent marking system, machine-generated, that does not show through the front of the plate.

3.4 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. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.
- D. 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.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 1. Test Instruments: Use instruments that comply with UL 1436.
 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. Tests for Convenience Receptacles:
 1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.

6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION

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FUSES
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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. Fuses.
 - 2. Spare Fuse Cabinet.
- B. The Electrical Contractor shall provide a complete set of fuses for all fusible equipment on the project as indicated on the Contract Documents. Final test and inspections shall be made prior to energizing the equipment.

1.3 PERFORMANCE REQUIREMENTS

- A. Select fuses to provide appropriate levels of short circuit and overcurrent protection for components such as wire, cable, bus structures, and other equipment. Provide system to ensure that component damage is within acceptable levels during a fault.
- B. Select fuses to coordinate with time-current characteristics of other overcurrent protective elements, such as other fuses, circuit breakers, and protective relays. Provide system to ensure that device closest to fault operates.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product Data for each fuse type specified. Include the following:
 - 1. Descriptive data and time-current curves.
 - 2. Let-through current curves for fuses with current-limiting characteristics
 - 3. Coordination charts and tables and related data.
- C. Field test reports indicating and interpreting test results.
- D. Maintenance data for tripping devices to include in the Operation and Maintenance Manual specified in Division 01.

- E. Record the equipment nameplate rating and actual fuse rating and location of fuses on the record drawings.
- F. Provide a complete short circuit coordination study report as required to select fuses to protect equipment.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses from one source and by a single manufacturer.
- B. Comply with NFPA 70 for components and installation.
- C. Listing and Labeling: Provide fuses specified in this Section that are listed and labeled.
 - 1. The terms *Listed* and *Labeled* as defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* (NRTL) as defined in OSHA Regulation 1910.7.
 - 3. Comply with National Electrical Manufacturer's Association NEMA FU-1 *Low Voltage Cartridge Fuses*.
 - 4. Comply with IEC269.
 - 5. Comply with CANENA Standard 248.
 - 6. Comply with UL 198.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Spare Fuses: Furnish quantity equal to 20 percent of each 600 ampere and small fuse type and size installed, but not less than one (1) set of three (3) of each type and size. (Provide three (3) of each 601 Ampere and larger fuse type and size installed.)
 - 2. Fuse Pullers: Furnish two (2) fuse pullers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering fuses that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper Industries Inc. Bussmann Div.

2. Eagle Electric Mfg, Co. Inc.
3. Ferraz Corp
4. General Electric Co; Wiring Devices Div.
5. Gould Shawmut.
6. Tracor, Inc; Littelfuse, Inc. Subsidiary

B. All fuses shall be of the same manufacturer to assure coordination.

2.2 CARTRIDGE FUSES

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

2.3 SPARE FUSE CABINET

- A. Cabinet: Wall mounted, 0.05 inch (1.27) mm) thick steel unit with full length, recessed piano-hinged door with key coded cam lock and pull, and circuit voltage.
1. Size: Adequate for orderly storage of spare fuses specified with 15 percent spare capacity minimum.
 2. Size: Adequate for orderly storage of spare fuses specified with 15 percent spare capacity minimum.
 3. Finish: Gray, baked enamel.
 4. Identification: Provide engraved nameplate to read “SPARE FUSES” in 1/2-inch letters on door. Refer to Division 26 Section, “Electrical Identification” for nameplate requirements.
 5. Fuse Pullers: For each size fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Main Service: Class L, fast acting, 600 Volt, 601-6000 Amp, and 300 kA interrupting rating.
- B. Main Feeders: Class J, time delay, 600Volt, 0-600 Amp, and 300 kA interrupting rating.
- C. Motor Branch Circuits: Class RK1, time delay, 250 Volt Class J Time Delay 600 Volt, 0-600 Amp, and 300 kA interrupting rating. Time delay fuses shall hold 500% of rated current for a minimum of 10 seconds.
- D. Other Branch Circuits: Class RK1, non-time delay, 250 Volt, Class J Time Delay 600 Volt, 0-600 Amp, and 300 kA interrupting rating.
- E. Provide fuses of type and rating recommended by equipment manufacturer for packaged and/or specialized equipment.
- F. Motor, transformer, feeder, and main service protection - 250 Volts or less:
 - 1. Six hundred (600) ampere and less in interrupter switches, Class RK1, dual elements, time delay, 300 kA interrupting rating.
 - 2. Four hundred (400) to six hundred (600) ampere in bolted pressure switches, Class J, 300 kA interrupting rating.
- G. Motor, transformer, feeder, and main service protection - 600 volts or less; 600 ampere and less - Class RK-1, dual element, time delay, 300 kA interrupting rating.
- H. Six hundred (600) ampere to six thousand (6000) ampere fuses used for protection of services, mains and feeders, Class L, current-limiting, time delay, 300 kA interrupting rating, rms symmetrical. Fuses shall be time delay and shall hold 500 percent of rated current for a minimum of four (4) seconds, clear 20 times rated current in 0.01 second or less, UL listed.
- I. Six hundred ampere or less, installed ahead of breaker: Class RK1, time delay.
- J. Six hundred ampere or less, for general power circuits: Class J, time-delay, dual element, 300 kA interrupting rating. Time-delay fuses shall hold 500 percent of rated current for a minimum of 10 seconds and shall be UL listed.
- K. Fuse sizes for motor protection shall be chosen from fuse manufacturers published data and recommendations.
- L. Control circuits and lighting: Class CC, current limiting rejection type, rated 0-30 amperes, 600 volts, and 200- kA interrupting rating.
- M. Motor Circuits: All individual motor circuits with full-load ampere ratings (FLA) of 480 amperes or less shall be protected by Dual-Element Time-Delay Fuses. The following guidelines apply for motors protected by properly sized overload relays: Fuses for motors with a marked service factor not less than 1.15 shall be installed in ratings of 125% of motor full-load current (or next size larger if 125 percent does not correspond to a fuse size), except where high ambient temperatures prevail, or where the motor drives a heavy revolving part

which cannot be brought up to full speed quickly, such as large fans. Under such conditions, the fuses may be 150 percent to 175 percent of the motor full-load current. For all other motors, (such as 1.0 service factor motors) fuses shall be sized in ratings of 115 percent of the motor full load current (or next size larger if 115 percent does not correspond to a fuse size) except as noted above. The following guidelines apply where fuses are used as the only overload protection for the motor:

1. For motors with a 1.15 service factor or more, fuses should be sized at 125 percent of motor full-load current (or next size smaller if 125 percent does not correspond to a fuse size).
 2. For all other motors, fuses should be sized at 115 percent of motor full-load current (or next size smaller, if 115 percent does not correspond to a fuse size).
- N. Motor Controllers: NEMA and IEC Style motor controllers shall be protected from short-circuits by Dual-Element Time-Delay fuses in order to provide testing agency-witnessed Type 2 coordination for the controller. This provides *no damage* protection for the controller, under low and high level fault conditions, as required by IEC Publication 947-4. For IEC style controller, the fuses shall be installed in ratings to coordinate with the overload relays, such that the relay/fuse curves cross over at 7-10 times the IEC contactor current rating.
- O. Panelboards: The manufacturer shall supply equipment utilizing fully-rated and listed components. This equipment shall be tested, listed, and labeled for the available short-circuit current.

3.3 INSTALLATION

- A. Fuses shall not be installed until equipment is ready to be energized. This measure prevents fuse damage during shipment of the equipment from the manufacturer to the job site, or from water that may contact the fuse before the equipment is installed. Final tests and inspections shall be made prior to energizing the equipment. This shall include a thorough cleaning, tightening, and review of all electrical connections and inspection of all grounding conductors. All fuses shall be furnished and installed by the electrical contractor. All fuses shall be of the same manufacturer. Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.
- B. Install spare fuse cabinet where indicated.
- C. Provide fuse clips as required.

3.4 IDENTIFICATION

- A. Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

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ENCLOSED SWITCHES AND CIRCUIT BREAKERS
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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. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers (MCCBs).
 - 4. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

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

- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Qualification Data: For qualified testing agency.
- D. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Operation and Maintenance Data: For enclosed switches and circuit breakers 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. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- 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.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NFPA 70.

1.6 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).

1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 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: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Fuse Pullers: Two for each size and type.

1.9 ALTERNATES

- A. Refer to Division 01 Section, “Alternates” for description of work under this section affected by alternates.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

2.2 FUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. ABB-GE Electrification Equipment.
 3. Siemens Energy & Automation, Inc.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, lockable in either open or closed positions, and interlocked with cover in closed position.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 4. Auxiliary Contact Kit: One NO/NC (Form “C”) auxiliary. Contacts would reactivate before blades open as indicated on the Drawings.
 5. Lugs: Compression type, suitable for number, size, and conductor material.
 6. Accessory Control Power Voltage: Remote-mounted and powered; 120-VAC. Provide as required with auxiliary contact kit.

2.3 NONFUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. ABB-GE Electrification Equipment.
 3. Siemens Energy & Automation, Inc.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, lockable in either open or closed position, and interlocked with cover in closed position.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Auxiliary Contact Kit: One NO/NC (Form “C”) auxiliary contacts, arranged to activate before switch blades open, where indicated in the Drawings.
4. Lugs: Compression type, suitable for number, size, and conductor material.
5. Accessory Control Power Voltage: Remote mounted and powered; 120 VAC. Provide as required with auxiliary contact kit.

2.4 SHUNT TRIP SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. ABB-GE Electrification Equipment.
 3. Siemens Energy & Automation, Inc.
- B. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: 600-V ac, ampacity as indicated on the drawings; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to accommodate specified fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- C. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: 600-V ac, ampacity as indicated on the drawings; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, pilot, indicating and control devices.
- E. Accessories:
 1. Oiltight key switch for key-to-test function.
 2. Oiltight green ON pilot light.
 3. Isolated neutral lug; 100 percent rating.
 4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
 5. Form C alarm contacts that change state when switch is tripped.
 6. Three-pole, double-throw, fire-safety and alarm relay; 24-V ac coil voltage, unless otherwise indicated on the drawings.
 7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

8. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
9. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
10. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
11. Hookstick Handle: Allows use of a hookstick to operate the handle.
12. Lugs: Compression type, suitable for number, size, and conductor material.
13. Service-Rated Switches: Labeled for use as service equipment.

2.5 MOLDED-CASE CIRCUIT BREAKERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. ABB-GE Electrification Equipment.
 3. Siemens Energy & Automation, Inc.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. 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.
- D. Features and Accessories:
 1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact, as indicated on the drawings.
 5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts, where indicated on the drawings.
7. Alarm Switch: One NO contact that operates only when circuit breaker has tripped, where indicated on the drawings.
8. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac, as required.
9. Provide with lockable handle, lockable in either open or closed position.

2.6 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 4X, stainless steel.
 3. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4. 4X, stainless steel.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 6. Hazardous Areas: NEMA 250, Type 7.
 7. Corrosive Locations: NEMA 250, Type 4X, polyester reinforced fiberglass.
- B. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- C. Operating Mechanism: The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- D. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- E. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- D. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:

- a. Inspect physical and mechanical condition.
- b. Inspect anchorage, alignment, grounding, and clearances.
- c. Verify that the unit is clean.
- d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
- e. Verify that fuse sizes and types match the Specifications and Drawings.
- f. Verify that each fuse has adequate mechanical support and contact integrity.
- g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
- i. Verify correct phase barrier installation.
- j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

- d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

E. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
- b. Inspect physical and mechanical condition.
- c. Inspect anchorage, alignment, grounding, and clearances.
- d. Verify that the unit is clean.
- e. Operate the circuit breaker to ensure smooth operation.
- f. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- g. Inspect operating mechanism, contacts, and chutes in unsealed units.
- h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's

- published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
 - e. Determine the following by primary current injection:
 - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
 - f. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
 - g. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
 - h. Verify operation of charging mechanism. Investigate units that do not function as designed.
- 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
 - F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
 - G. Prepare test and inspection reports.
 - 1. Test procedures used.
 - 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.

3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

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

END OF SECTION

DIVISION 26 SECTION 26 29 13
ENCLOSED CONTROLLERS
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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. Multispeed controllers.
- B. Related Sections include the following:
 - 1. Mechanical Divisions for “Variable Speed Drives” and “Power Factor Correction Capacitors”.

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. 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. Qualification Data: For manufacturer and testing agency.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For enclosed controllers 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 enclosed controllers and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- G. 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. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.
- D. 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.
- E. Comply with NFPA 70.
- F. 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 installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
- C. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- D. 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.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
 - 2. Indicating Lights: Two of each type installed.

1.8 ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:
 - 1. Eaton Corporation; Cutler-Hammer Products.

2. ABB-GE Electrification Equipment.
3. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
4. Siemens/Furnas Controls.

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 10 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 source of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity. Control power transformers shall have primary and secondary fuse protection.
 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 homeplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
- C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
 1. Non-fusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch unless otherwise noted on the drawings.
 2. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
 3. MCP Disconnecting Means: UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.3 ENCLOSURES

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

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 4X, stainless steel.
 3. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4. 4X, stainless steel.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 6. Hazardous Areas: NEMA 250, Type 7.
 7. Corrosive Locations: NEMA 250, Type 4X, polyester reinforced fiberglass.
- B. Provide lockable handle for combination starter and disconnects that accepts three padlocks and interlocks with cover in closed position.

2.4 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Push-to-Test Red “Power Available” and Green “Running” non-incandescent, Pilot Lights, and Hand-Off-Automatic Selector Switches: NEMA ICS 2, heavy-duty type.
- C. Control Relays: Two (2) NO/NC auxiliary contacts and adjustable time-delay relays as required by automatic control sequence.
- D. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

2.5 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. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."
- C. Install Power Factor Correction Capacitors furnished under Mechanical Divisions with disconnects, overcurrent protection, wire, conduit and ground for capacitor enclosure, all in accordance with the recommendations of the capacitor manufacturer and the National Electric Code.
- D. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

3.4 IDENTIFICATION

- A. Identify enclosed controller, components, and control wiring according to Section 260553 "Identification for Electrical Systems."

3.5 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.
 - 2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 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 Section "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. 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.
- C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- D. Perform the following field tests and inspections and prepare test reports:
 - 1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
 - 2. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with drawings and specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, and grounding.
 - d. Verify the unit is clean.
 - e. Inspect contactors:
 - 1) Verify mechanical operation.
 - 2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
 - f. Motor-Running Protection:
 - 1) Verify overload element rating is correct for its application.
 - 2) If motor-running protection is provided by fuses, verify correct fuse rating.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate

- values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
- 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
3. Electrical Tests:
 - a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than those of this table or manufacturer's recommendations shall be investigated and corrected.
 - b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - c. Test motor protection devices according to manufacturer's published data.
 - d. Test circuit breakers as follows:
 - 1) Operate the circuit breaker to ensure smooth operation.
 - 2) For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.
 - e. Perform operational tests by initiating control devices.
 4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.8 ADJUSTING

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

3.9 DEMONSTRATION

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

END OF SECTION

DIVISION 26 SECTION 26 41 13
LIGHTNING PROTECTION SYSTEM
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SECTION 26 41 13
LIGHTNING PROTECTION 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 SUMMARY

- A. Section includes a UL Master Label lightning protection system for the buildings and associated structures, to be provided under Alternate #13.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
 - 1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
 - 2. Include raceway locations needed for the installation of conductors.
 - 3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
 - 4. Include roof attachment details, coordinated with roof installation.
 - 5. Calculations required by NFPA 780 for bonding of metal bodies.
- C. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Lightning protection cabling attachments to roofing systems and accessories.
 - 2. Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.
 - 3. Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.
- D. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.
- E. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.

- F. Field quality-control reports.
- G. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D
- H. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
 - 1. Ground rods.
 - 2. Down conductors.
 - 3. Surge Protection Devices.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Certified by UL and LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.
- B. System Certificate:
 - 1. UL Master Label.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.5 COORDINATION

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
- C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. East Coast Lightning Equipment Inc.
 - 2. ERICO International Corporation.
 - 3. Harger.

4. Heary Bros. Lightning Protection Co. Inc.
 5. Independent Protection Co.
 6. Preferred Lightning Protection.
 7. Robbins Lightning, Inc.
 8. Thompson Lightning Protection, Inc.
- B. Comply with UL 96 and NFPA 780 requirements for Class I buildings.
- C. Roof-Mounted Air Terminals: NFPA 780, Class I, aluminum unless otherwise indicated.
1. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.
 2. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in Division 07 roofing Sections.
 3. Provide protection caps on air terminal located at high traffic roof areas, walkways and service areas.
- D. Main and Bonding Conductors: Aluminum, except down conductors will be Copper.
- E. Ground Loop Conductor: The same size and type as the main conductor except tinned.
- F. Ground Rods: Copper-clad steel; 3/4 inch (19 mm) in diameter by 10 feet (3 m) long.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.
- C. Conceal conductors within normal view from exterior locations at grade within 200 feet (60 m) of building. Comply with requirements for concealed systems in NFPA 780.
 1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.

2. Install conduit where necessary to comply with conductor concealment requirements.
- D. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.
 1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
- F. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

3.2 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

- A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
- B. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
 1. Perform inspections as required to obtain a UL Master Label for system.
- C. Prepare test and inspection reports and certificates.

END OF SECTION

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SURGE PROTECTIVE DEVICES
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SECTION 26 43 13
SURGE PROTECTIVE 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. Description: This section describes the materials and installation requirements for integral and stand alone Surge Protective Devices (SPDs) for the protection of all AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching. SPD's shall be installed integral with equipment unless otherwise indicated.
- B. Refer to Division 26 Section 262413, *Switchboards* for SPDs installed within electrical switchboards.

1.3 DEFINITIONS

- A. Inominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: air of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. NRTL: Nationally recognized testing laboratory.
- F. OCPD: Overcurrent protective device.
- G. SCCR: Short-circuit current rating.
- H. SPD: Surge protective device.
- I. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.
- J. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.
- K. VPR: Voltage protection rating.

1.4 REFERENCES

- A. ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits.
- B. ANSI/IEEE C62.45 - IEEE Recommended Practice on Surge Suppressor Testing.
- C. FIPS Pub 94 (1983) - Guide on Electrical Power for ADP Installation.
- D. National Electrical Code - Article 285
- E. National Fire Protection Association - NFPA-20, NFPA-70, NFPA-75, NFPA-78.
- F. NEMA LS-1 Low Voltage Surge Protection Devices.
- G. NEMA 250 - Enclosures for Electrical Equipment.
- H. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.
- I. UL 1283 - Electromagnetic Interference Filters.
- J. UL 1449, Fourth Edition - Surge Protective Devices.

1.5 SUBMITTALS

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated. Indicate overcurrent protection requirements.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- C. Maintenance Data: For surge protective devices to include in the maintenance manuals specified in Division 01.
- D. Warranties: Special warranties as specified in this Section.
- E. The submittals shall include:
 - 1. UL 1449, Fourth Edition Listing documentation verifying:
 - a. Short Circuit Current Rating (SCCR)
 - b. Voltage Protection Ratings (VPRs) for all modes
 - c. Maximum Continuous Operating Voltage (MCOV) rating
 - d. I-nominal (I-n) rating
 - e. Type 1 Device listing
 - 2. VPR, MCOV, I-n and Type 1 information is posted at www.UL.com, under Certifications. SCCR's are posted in manufacturer's UL documents.

3. UL Standard 1283 Listing, documentation.
 4. UL data and visual inspection take precedence over manufacturer's published documentation.
- F. Submittals shall include shop drawings including the following:
1. Manufacturer's installation instruction manual and line drawings detailing dimensions and weights of enclosure.
 2. Internal wiring diagram illustrating all modes of protection in each type of SPD required.
 3. Wiring diagram showing all field connections and manufacturer's recommended wire and circuit breaker sizes.
- G. Upon request, an encapsulated but complete SPD shall be presented for visual inspection. MOV type & quantity shall reflect kA ratings on product data sheets, verification of diagnostic monitoring, thermal & overcurrent protection, etc.

1.6 QUALITY ASSURANCE

- A. Listing and Labeling: Provide electrically operated equipment specified in this Section that is listed and labeled.
1. The Terms *Listed* and *Labeled*: As defined in the National Electrical Code, Article 100.
 2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* as defined in OSHA Regulation 1910.7.
 3. Comply with NFPA-70.

1.7 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the contract Documents and shall be in addition to, and run concurrent with, other warranties made under requirements of the Contract Documents.
- B. Special Warranty: A written warranty, executed by manufacturer, agreeing to repair or replace components of Surge Protective Devices that fail in materials or workmanship within the specified warranty period.
1. Warranty Period: Five (5) years (minimum) from date of Substantial Completion.

PART 2. PRODUCTS

2.1 MANUFACTURERS

- A. Provide integral SPD from equipment manufacturer that meets the following requirements. For external devices, the following listed manufacturers provide units of acceptable quality. Verify that all proposed units meet the specified requirements.
1. Advanced Protection Technologies, Inc.
 2. EFI Electronics Corporation.
 3. Liebert Corporation.
 4. Current Technology, Inc.
 5. LEA Dynatech, Inc.

2.2 SURGE PROTECTIVE DEVICES

- A. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per NEC 285.6.
- B. SPD shall be UL labeled as Type 1 (verifiable at UL.com), intended for use without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal over-temperature controls. SPDs relying upon external or supplementary installed safety disconnects do not meet the intent of this specification.
- C. SPD shall be UL labeled with 20kA I-nominal (I-n) (verifiable at UL.com) for compliance to UL 96A Lightning Protection Master Label and NFPA 780.
- D. Suppression components shall be heavy duty ‘large block’ MOVs, each exceeding 30mm diameter.
- E. Minimum surge current capability (single pulse rated) per phase shall be:

Service Entrance or Transfer Switch:	300kA
Distribution Panelboards & MCC:	200kA
Branch Panelboards:	100kA

- F. SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
- G. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

<u>System Voltage</u>	<u>L-N</u>	<u>L-G</u>	<u>L-L</u>	<u>N-G</u>
208Y/120	700V	700V	1200V	700V
480Y/277	1200V	1200V	1800V	1200V

(Mode VPRs verifiable at UL.com. Numerically lower is allowed/preferred; old-style Suppressed Voltage Ratings (SVRs) shall not be submitted, nor evaluated due to outdated less-strenuous testing)

- H. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV):

<u>System Voltage</u>	<u>Allowable System Voltage Fluctuation (%)</u>	<u>MCOV</u>
208Y/120	25%	150V
480Y/277	15%	320V

- I. SPD shall include a serviceable, replaceable module (excluding Branch).
- J. SPD shall have UL 1283 EMI/RFI filtering with minimum attenuation of -50dB at 100kHz.
- K. SPD shall include visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED. SPD shall include an audible alarm with on/off silence function and diagnostic test function (excluding branch).
- L. SPD shall be provided with the following options:
1. One (1) set of NO/NC dry contacts
 2. Surge event counter with back-up power source
 3. Integral disconnect switch.

2.3 ENCLOSURES

- A. Mount integral in panel enclosure unless otherwise indicated. For applications where stand alone mounting is indicated or required, provide the following enclosures:
1. Indoor Enclosures: NEMA 250, Type 1.
 2. Outdoor Enclosures: NEMA 250, Type 4X.

PART 3. EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.

- E. 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.

3.2 FIELD QUALITY CONTROL

- a. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
 - 2. Before energizing electrical circuitry, verify that the unit voltage and connecting equipment voltage is the same.
 - 3. Inspect anchorage, alignment, grounding, and clearances.
 - 4. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- b. An SPD will be considered defective if it does not pass tests and inspections.
- c. Prepare test and inspection reports.

3.3 STARTUP SERVICE

- a. Complete startup checks according to manufacturer's written instructions. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.
- b. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.
- c. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

- a. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION

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INTERIOR LIGHTING
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**SECTION 26 51 00
INTERIOR LIGHTING**

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. Interior lighting fixtures.
2. LED lamps and drivers.
3. Emergency lighting units.
4. Exit signs.
5. Integral Emergency Lighting Power Units.
6. Lighting fixture supports.

B. Related Sections:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Division 26 Section "Wiring Devices" for snap switches and wall switches.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. Fixture: See "Luminaire."
- D. IP: Ingress Protection or International Protection Rating.
- E. LED: Light emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, driver, reflector, and housing.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Emergency lighting units including battery and charger.
 - 3. Drivers, including energy-efficiency data.
 - 4. Energy-efficiency data.
 - 5. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
 - 6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, for each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project. Comply with IES LM-79, IES LM-80.
 - a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, and mounting and attachment details.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples: For each lighting fixture indicated in the Interior Lighting Fixture Schedule. Each Sample shall include the following:
 - 1. Lamps and drivers, installed.
 - 2. Cords and plugs.
- D. Installation instructions.
- E. Product Certificates: For each type of driver for bi-level and dimmer-controlled fixtures, from manufacturer.
- F. Field quality-control reports.
- G. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

H. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products and complying with applicable IES testing standards.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
 2. Warranty Period for Emergency Battery Pack and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.
- B. Special Warranty for Drivers: Manufacturer's standard form in which driver manufacturer agrees to repair or replace drivers that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Electronic Drivers: Five years from date of Substantial Completion.

1.8 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. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Battery and Charger Data: One for each emergency lighting unit.
 - 4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.
 - 5. LED Modules (light engine and driver): Furnish at least (1) of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Basis of Design Product: The design of each item of interior luminaire is based on the product named. Subject to compliance with requirements, provide either the named product or an approved equal.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Metal Parts: Free of burrs and sharp corners and edges.
- C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- E. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125-inch (3.175 mm) minimum unless otherwise indicated.
 - b. UV stabilized.
 2. Glass: Annealed crystal glass unless otherwise indicated.
- F. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp and ballast characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage and coating.
 - c. CCT and CRI for all luminaires.
- G. Recessed luminaires shall comply with NEMA LE 4.

2.3 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-metal hydride type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.4 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
1. Battery: Sealed, maintenance-free, nickel-cadmium type.
 2. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
 7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
 8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.5 LED LAMPS/LUMINAIRES

- A. LED Luminaires: A LED luminaire consists of LED light engine and driver, heat-sink, fixture housing, and optic assembly where applicable.
1. Temperature: Minimum starting temperature of -30 deg C (-22 deg F), minimum 40 deg C (104 deg F) ambient temperature rating.
 2. Life and Lumen Maintenance: L70 lamp life of 50,000 hours.
 3. CRI and CCT: 3500 deg K (+/- 275 K) CCT and greater than 80 CRI.
 4. Transient Voltage Protection: Rated to withstand 2.5 kV of transient line surge.
 5. Photometric Data and Test Reports: Comply with IESNA LM-79-19, IESNA LM-80-15, and ANSI C78.377-17.
 6. Radio Frequency Interference: Comply with CAP 106B Telecommunications (Control of Interference) Regulations.

7. Luminaires and components thereof shall comply with UL 8750 Standard of Safety.
8. Five-year warranty on luminaire including LED light engine and driver.
9. Power Factor: 90 percent minimum.
10. Total Harmonic Distortion Rating: Less than 20 percent.
11. RoHS compliant.
12. Sound Rating: Class A.
13. Overload, short circuit, and thermal protection.
14. Comply with UL 1598-14 NMX-J-307/1-ANCE/C22.2 NO.250-0-14, *Luminaires, LEDs*.

2.6 INTEGRAL EMERGENCY LIGHTING POWER UNITS

- A. Provide emergency lighting power supply units for fixtures indicated on the drawings with integral emergency battery unit as specified herein.
 1. Each fixture indicated to be provided with an emergency driver shall be provided with an emergency power supply unit which consists of a package assembly containing a high-temperature maintenance-free lithium ion battery, a rectifier/battery charger, a DC to AC inverter contained in one metal enclosure. Emergency drivers shall be provided in conjunction with the AC LED driver provided with the fixture, compatible with the driver output current (max 5A). The battery shall have a normal life expectancy of 10 to 15 years with sufficient capacity to operate the lamp load at full normal brightness for 90 minutes. Units shall be UL approved for compliance with UL Standard 924 “Emergency Lighting and Power Equipment.”
 2. Each unit shall be unconditionally guaranteed for a period of three years, with an additional three year pro-rated guarantee on the storage battery.
- B. Operating Modes
 1. Each emergency power supply unit shall automatically operate the lamp in the event of an AC power system failure for 90 minutes. When AC power is restored, the emergency power supply unit shall automatically return to the charging mode.
 - a. MODE 1: Lamp is controlled by a switched AC ON/OFF circuit. Lamp automatically turns ON when AC power is lost. The unit is shipped from the factory connected for this mode of operation.
 - b. MODE 2: Same as MODE 1 except lamp does not automatically turn ON when AC power is lost. This mode is established by adding a jumper between the AUTO and GND terminals.

- c. MODE 3: The unit can be used to provide continuous unswitched, uninterruptible light. A switched AC circuit is not used for this mode. To establish this mode of operation, connect a jumper between the OVER and GND terminals.
 - d. MODE 4: The unit can be used to provide an unswitched light which is normally OFF but which automatically turns on when AC power is lost. This mode of operation is established by connecting only the unswitched AC circuit to the power supply unit.
 - e. MODE 5: Lamp is turned on by external switch or relay contacts. The switched AC ON/OFF circuit is optional in this mode. The switch contacts "override" the (optional) switched AC circuit to turn the lamp on. In order for the lamp to be OFF, the external switch contacts must be open AND the switched AC circuit (if used) must be OFF. This mode is established by connecting the switch contacts to OVER and GND. In this mode, the lamp will also be automatically turned ON in the event of AC power failure, unless this feature is disabled by connecting a jumper between the AUTO and GROUND terminals.
- C. Power supply units for emergency lighting shall be provided with remote test switch to be mounted flush in ceiling adjacent to fixture. Power supply units shall be Bodine 10W BSL10T3U series self-testing/self-diagnostic Class 2 output, Emergi-Lite (unless otherwise noted), or the same manufacturer of the lighting fixture as noted in the Lighting Fixture Schedule.

2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gauge (2.68 mm).
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge (2.68 mm).
- F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug EXECUTION.

2.8 GENERAL

- A. Comply with NECA/IESNA 500-2006 "Standard for Installing Indoor Commercial Lighting systems."

2.9 INSTALLATION

- A. Lighting fixtures:
 - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
 - 2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Remote Mounting of Drivers: Distance between the driver and fixture shall not exceed that recommended by driver manufacturer. Verify, with driver manufacturers, maximum distance between driver and luminaire.
- D. Integral Emergency Lighting Power Units:
 - 1. Power supply units for emergency lighting shall be mounted on the top of the fixture housing as recommended by the manufacturer. If required, the units shall be permitted to be remote mounted up to 50 feet from the fixture per manufacturer's distant limitations, mounted on the building structure above the ceiling space. Where units are remote mounted, the final four-foot length of connecting raceway shall be Greenfield flexible metallic conduit to facilitate fixture removal.
 - 2. Note that wherever an emergency lighting power supply unit is used in a circuit controlled by a light switch, a four wire connection to the AC power source is required - the switched wire, the hot wire, the neutral and ground.
- E. Lay-in Ceiling Luminaire Supports: Use grid as a support element.
 - 1. Install ceiling support system wires (Solid#12AWG safety wire), independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
- F. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.

2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
- G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

2.10 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

2.11 FIELD QUALITY CONTROL

- A. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- B. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- C. Luminaire will be considered defective if it does not pass operation tests and inspections.
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

2.12 STARTUP SERVICE

- A. Comply with requirements for startup specified in Section 260923 "Lighting Control Devices."

2.13 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.

2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust aimable luminaires in the presence of Architect.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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EXTERIOR LIGHTING
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SECTION 26 56 00
EXTERIOR LIGHTING

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. Exterior luminaires, materials, and finishes.
 - 2. LED lamps and drivers.
 - 3. Luminaire-mounted photoelectric relays.
 - 4. Poles and accessories
- B. Related Sections include the following:
 - 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
 - 2. Section 265100 "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. EPA: Equivalent projected area.
- D. Fixture: See "Luminaire."
- E. IP: Ingress Protection or International Protection Rating.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, driver, reflector, and housing.
- H. LED: Light-emitting diode.
- I. Pole: Luminaire support structure.

J. Standard: Same definition as “Pole” above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-6-M.
- B. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-6-M.
- C. Ice Load: Load of 3 lbf/sq. ft. (143.6 Pa), applied as stated in AASHTO LTS-6-M.
- D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-6-M.
 - 1. Wind speed for calculating wind load for poles 50 feet (15 m) or less in height is 80 mph (129 km/h).

1.5 ACTION SUBMITTALS

- A. Product Data: For each luminaire and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of luminaire, including materials, dimensions, weights, effective projected area, and verification of indicated parameters.
 - 2. Details of attaching luminaires and accessories.
 - 3. Details of installation and construction.
 - 4. Luminaire materials.
 - 5. Photometric data and adjustment factors based on laboratory tests of each luminaire type, complete with indicated lamps, drivers, and accessories. Comply with IES LM-79, IES LM-80.
 - a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 - b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - 6. Photoelectric relays.
 - 7. Drivers, including energy-efficiency data.
 - 8. Lamps, including life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 9. Materials, dimensions, and finishes of poles.

10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
 11. Anchor bolts for poles.
 12. Manufactured pole foundations.
- B. Shop Drawings:
1. Include plans, elevations, sections and mounting and attachment details.
 2. Include details of luminaire assemblies. Indicate dimensions, weights loads, required clearances, method of field assembly, and location and size of each field connection.
 3. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
 4. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
 5. Wiring Diagrams: Power, signal, and control wiring.
 6. Lighting Calculations: Point-by-point calculations for fixtures shown on the Site Plan and noted on the Lighting Fixture Schedule. Calculation grid shall be maximum 10'-0" on center, horizontal.
- C. Samples for Verification: For products designated for sample submission in Exterior Lighting Fixture Schedule. Each sample shall include lamps and drivers. Finish samples shall be provided upon request.
- D. Pole and Support Component Certificates: Signed by manufacturers, certifying that products are designed for indicated load requirements in AASHTO LTS-6-M and that load imposed by luminaire has been included in design.
- E. Qualification Data: For agencies providing photometric data for lighting fixtures.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products and complying with applicable IES testing standards.
- B. Provide luminaires from a single manufacturer for each luminaire type.

- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- D. 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.
- E. Comply with IEEE C2, "National Electrical Safety Code."
- F. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
 - 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
 - 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
 - 4. Warranty Period for Lamps: Replace lamps and fuses that fail within 24 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 24 months from date of Substantial Completion.
 - 5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than five years from date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Glass, Acrylic and Plastic Lenses, Covers, and Other Optical Parts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
4. LED Modules (light engine and driver): Furnish at least (1) of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 2. Basis of Design Product: The design of each item of exterior luminaire and its support is based on the product named. Subject to compliance with requirements, provide either the named product or an approved equal.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit maintenance without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during maintenance and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect driver when door opens.

- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- M. Factory-Applied Finish for Steel luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected from manufacturer's standard catalog of colors.
- N. Factory-Applied Finish for Aluminum luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

2.3 LED LAMPS/LUMINAIRES

- A. LED Luminaires: A LED luminaire consists of LED light engine and drive, heat-sink, fixture housing, and optic assembly where applicable.
1. Temperature: Minimum starting temperature of -30 deg C (-22 deg F), minimum 40 deg C (104 deg F) ambient temperature rating.
 2. Life and Lumen Maintenance: L70 lamp life of 50,000 hours.CRI and CCT: 3000 deg K (+/- 275 K) CCT and greater than 70 CRI.
 3. Transient Voltage Protection: Rated to withstand 10 kV of transient line surge.
 4. Photometric Data and Test Reports: Comply with IESNA LM-79-08, IESNA LM-80-08, and ANSI C78.377-08.
 5. Radio Frequency Interference: Comply with CAP 106B Telecommunications (Control of Interference) Regulations.
 6. Luminaires and components thereof shall comply with UL 8750 Standard of Safety.
 7. Five-year warranty on luminaire including LED light engine and driver.
 8. Power Factor: 90 percent minimum.
 9. Total Harmonic Distortion Rating: Less than 20 percent.
 10. RoHS compliant.
 11. Sound Rating: Class A.
 12. Overload, short circuit, and thermal protection.

2.4 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-6-M.
1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 - 1. Materials: Shall not cause galvanic action at contact points.
 - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
 - 3. Anchor-Bolt Template: Plywood or steel.
- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

2.5 STEEL POLES

- A. Poles: Comply with ASTM A500/A500M, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); 1-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
 - 1. Shape: Round, straight; Square, straight.
 - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Brackets for Luminaires: Detachable, cantilever, without underbrace.
 - 1. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
 - 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
 - 3. Match pole material and finish.
- C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- D. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches (65-by-130-mm) with cover secured by stainless-steel captive screws.
- E. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- G. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.

- H. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
 - 3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected by Architect from manufacturer's full range.
- I. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Powder Coat: Comply with AAMA 2604.
 - a. Electrostatic-applied powder coating; single application and cured to a minimum 2.5- to 3.5-mils (64- to 89-um) dry film thickness. Coat interior and exterior of pole for equal corrosion protection.
 - b. Color: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 GENERAL

- A. Comply with NECA/IESNA 501-2006 "Standard for Installing Exterior Lighting Systems".

3.2 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

- C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

3.3 POLE INSTALLATION

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
 - 1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
 - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
 - 3. Trees: 15 feet (5 m).
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer's written instructions.
 - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
 - 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
 - 3. Install base covers, unless otherwise indicated.
 - 4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- E. Raise and set poles using web fabric slings (not chain or cable).

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

- A. Install on concrete base with top minimum 6 inches (100 mm) above finished grade or surface at luminaire location, unless otherwise noted. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

- B. Steel Conduits: Comply with Division 26 Section "Raceways and Boxes." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole, unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.7 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
 - 1. Verify operation of photoelectric controls.
- C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaires. Refer to Division 01 Section that includes Demonstration and Training.

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EXTERIOR ATHLETIC LIGHTING
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SECTION 26 56 68 - EXTERIOR ATHLETIC LIGHTING

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. Luminaires, lamps, and ballasts.
2. Support structures.
3. Power distribution and control.
4. Surge protection.
5. Pole and base protection.
6. Poles and accessories for support of luminaires.
7. Luminaire-lowering devices.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic and remote control of lighting, including time switches, photoelectric relays, and multiple lighting relays and contactors.
2. Section 265619 "Exterior Lighting" for exterior LED luminaires and photoelectric relays.

- C. The purpose of these specifications is to define the lighting system performance and design standards for this project using an LED Lighting source. The manufacturer / contractor shall supply lighting equipment to meet or exceed the standards set forth in these specifications.

D. The primary goals of this sports lighting project are:

1. **Guaranteed Light Levels:** Selection of appropriate light levels impact the safety of the players and the enjoyment of spectators. Therefore, light levels are guaranteed to not drop below specified target values for a period of 10 years.
2. **Environmental Light Control:** It is the primary goal of this project to minimize spill light to adjoining properties and glare to the players, spectators and

neighbors. Lighting shall be in compliance with New Castle County, Delaware requirements.

3. Cost of Ownership: In order to reduce the operating budget, the preferred lighting system shall be energy efficient and cost effective to operate. All maintenance costs shall be eliminated for the duration of the warranty.
4. Control and Monitoring: To allow for optimized use of labor resources and avoid unneeded operation of the facility, customer requires a remote on/off control system for the lighting system. Fields should be proactively monitored to detect luminaire outages over a 10-year life cycle. All communication and monitoring costs for 10-year period shall be included in the bid.

1.3 LIGHTING PERFORMANCE

- A. Illumination Levels and Design Factors: Playing surfaces shall be lit to an average target illumination level and uniformity as specified in the chart below. Lighting calculations shall be developed and field measurements taken on the grid spacing with the minimum number of grid points specified below. Appropriate light loss factors shall be applied and submitted for the basis of design. Average illumination level shall be measured in accordance with the IESNA LM-5-04 (IESNA Guide for Photometric Measurements of Area and Sports Lighting Installations). Illumination levels shall not drop below desired target values in accordance to IES RP-6-15, Page 2, Maintained Average Illuminance and shall be guaranteed for the full warranty period.

Area of Lighting	Average Target Illumination Levels	Maximum to Minimum Uniformity Ratio	Grid Points	Grid Spacing
Football (Stadium)	50	2.5:1:0	72	30' x 30'
Football (Practice)	30	2.5:1:0	72	30' x 30'
Track	15	30:1:0	44	30'

- B. Color: The lighting system shall have a color temperature of 5700K and a minimum CRI of 75.
- C. Mounting Heights: To ensure proper aiming angles for reduced glare and to provide better playability, minimum mounting heights shall be as described below. Higher mounting heights may be required based on photometric report and ability to ensure the top of the field angle is a minimum of 10 degrees below horizontal.

# of Poles	Pole Designation	Pole Height
6 (Stadium/Track)	SSL1,SSL2,SSL3,SSL4, SSP1,SSP2	80'
# of Poles	Pole Designation	Pole Height
4 (Practice)	SSL5,SSL6,SSL7,SSL8	80'

1.4 ENVIRONMENTAL LIGHT CONTROL

- A. Light Control Luminaires: All luminaires shall utilize spill light and glare control devices including, but not limited to, internal shields, louvers and external shields. No symmetrical beam patterns are accepted.
- B. Glare Control: Maximum candela values at a distance of 150 feet and a height of 3 feet are defined for typical sports fields below.

Typical Field Type	Maximum Candela at 150 feet
Football/Soccer/Track	<12,000 candela

- C. Spill Scans: Spill scans must be submitted indicating the amount of horizontal and vertical footcandles along the specified lines. Light levels shall be taken at 30-foot intervals along the boundary line. Readings shall be taken with the meter orientation at both horizontal and aimed towards the most intense bank of lights. Illumination level shall be measured in accordance with the IESNA LM-5-04.
- D. The first page of a photometric report for all luminaire types proposed showing horizontal and vertical axial candle power shall be provided to demonstrate the capability of achieving the specified performance. Reports shall be certified by a qualified testing laboratory with a minimum of five years experience or by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products. A summary of the horizontal and vertical aiming angles for each luminaire shall be included with the photometric report.

1.5 COST OF OWNERSHIP

- A. Manufacturer shall submit a 10 year Cost of Ownership summary that includes energy consumption, anticipated maintenance costs, and control costs. All costs associated with faulty luminaire replacement - equipment rentals, removal and installation labor, and shipping - are to be included in the maintenance costs.

1.6 DEFINITIONS

- A. ACN: Architecture for Control Networks.
- B. CCT: Correlated color temperature; a measure of the chromaticity (yellowness or blueness) of a white light source, expressed as the absolute temperature in kelvins of a blackbody radiator having similar chromaticity.
- C. CRI: Color rendering index; a unitless estimation of how accurately a white light source displays the colors of reflected surfaces.

- D. Coefficient of Variation (CV): A statistical measure of the weighted average of all relevant illumination values for the playing area, expressed as the ratio of the standard deviation for all illuminance values to the mean illuminance value.
- E. Fixture: See "Luminaire."
- F. Illuminance: The metric most commonly used to evaluate lighting systems. It is the density of luminous flux, or flow of light, reaching a surface divided by the area of that surface.
 - 1. Horizontal Illuminance: Measurement in foot-candles (lux), on a horizontal surface 36 inches (914 mm) above ground unless otherwise indicated.
 - 2. Target Illuminance: Average maintained illuminance level, calculated by multiplying initial illuminance by LLF.
 - 3. Vertical Illuminance: Measurement in foot-candles (lux), in two directions on a vertical surface, at an elevation coinciding with plane height of horizontal measurements.
- G. LC: Lighting Certified.
- H. Light-Loss Factor (LLF): A factor used in calculating the level of illumination after a given period of time and under given conditions. It takes into account temperature, dirt accumulation on the luminaire, lamp depreciation, maintenance procedures, and atmospheric conditions. An LLF includes a recoverable light-loss factor.
- I. Luminaire: A complete lighting unit, internally lighted exit sign, or emergency lighting unit. Luminaires include lamps and the parts required to distribute light, position and protect lamps, and connect lamps to power supply. Note that "fixture" and "luminaire" may be used interchangeably and the "IES Lighting Handbook" uses "luminaire" over "fixture."
- J. Pole: Luminaire support structure, including tower used for large area illumination.
- K. SPD: Surge protective device.
- L. Standard: See "Pole."
- M. Uniformity Gradient (UG): The rate of change of illuminance on the playing field, expressed as a ratio between the illuminances of adjacent measuring points on a uniform grid.
- N. UGR: Unified glare rating.

1.7 DELEGATED DESIGN SERVICES

- A. Delegated Design Professionals:

1. Engage qualified lighting design professional to design athletic field lighting equipment.
2. Engage qualified structural professional engineer to design poles, hangers, and supports for athletic field lighting equipment.

1.8 ACTION SUBMITTALS

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

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of the luminaires.
4. Ballast, including BF, UL listing and recognition, ANSI certification, and Energy Independence and Security Act of 2007 compliance.
5. Lamps, including life, output (lumens, CCT, and CRI), and energy-efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides," of each lighting luminaire type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the luminaire as applied in this Project.
 - a. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 - b. Manufacturer Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
7. Photoelectric relays.
8. Means of attaching luminaires to supports and indication that attachment is suitable for components involved.
9. Include sample warranty language.
10. Product Certificates:
 - a. For each type of bilevel and dimmer-controlled luminaire ballast, signed by product manufacturer.
 - b. For support structures, including brackets, arms, appurtenances, bases, anchorages, and foundations, signed by product manufacturer.

B. Product Data: For each pole, accessory, and luminaire-supporting and -lowering device, arranged as indicated.

1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
 2. Include finishes for lighting poles and luminaire-supporting devices.
 3. Anchor bolts.
 4. Manufactured pole foundations.
- C. Shop Drawings: For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment details.
 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.
- D. Shop Drawings: For poles, accessory, and luminaire-supporting and -lowering devices.
1. Include plans, elevations, sections, and mounting and attachment details.
 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Detail fabrication and assembly of poles and pole accessories.
 4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
 5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
 6. Method and procedure of pole installation. Include manufacturer's written installations.
- E. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.
- F. Delegated-Design Submittal: For exterior athletic lighting 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 and specifications for construction of lighting system.
 2. Manufacturer's determination of LLF used in design calculations.

3. Lighting system design calculations for the following:
 - a. Target illuminance.
 - b. Point calculations of horizontal and vertical illuminance, CV, and UG at minimum grid size and area.
 - c. Point calculations of horizontal and vertical illuminance in indicated areas of concern for spill light.
 - d. Calculations of source intensity of luminaires observed at eye level from indicated properties near the playing fields.
4. Luminaire layout and aiming diagrams.
5. Electrical system design calculations for the following:
 - a. Short-circuit current calculations for rating of panelboards.
 - b. Total connected and estimated peak-demand electrical load, in kilowatts, of lighting system.
 - c. Capacity of feeder required to supply lighting system.
6. Wiring requirements, including required conductors, cables, and wiring methods.
7. Structural analysis data and calculations used for pole selection.
 - a. Manufacturer Wind-Load Strength Certification: Submit certification that selected total support system, including poles, complies with AASHTO LTS-6-M for location of Project.
 - b. Luminaire mounting arrangement.

1.9 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Luminaires.
 2. Luminaire support structures.
 3. Limits of athletic fields.
 4. Proposed underground utilities and structures.
 5. Existing underground utilities and structures.
 6. Athletic field support structures.
 7. Poles and foundations.

- B. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements according to AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations signed and sealed by a professional engineer.
- C. Qualification Data: For qualified Installer, manufacturer, professional engineer, testing laboratory providing photometric data for luminaires and field testing agency.
- D. Seismic Qualification Data: Certificates, for luminaires, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Welding certificates.
- F. Product Certificates:
 - 1. For each type of driver for bi-level and dimmer-controlled luminaire, from manufacturer.
 - 2. For support structures, including brackets, arms, appurtenances, bases, anchorages, and foundations, from manufacturer.
- G. Material Test Reports:
 - 1. For each foundation component, by a qualified testing agency.
 - 2. For each pole, by a qualified testing agency.
- H. Field quality-control reports.
- I. Sample warranty.
- J. Soil test reports

1.10 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.

- B. Operation and Maintenance Data: For poles to include in emergency, operation, and maintenance manuals.

- 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include pole inspection and repair procedures.

1.11 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- 1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Drivers: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Fuses: Ten for every 100 of each type and rating installed. Furnish at least one of each type.

- B. Pole repair materials.

1.12 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

- B. Manufacturer Qualifications: Manufacturer's responsibilities include fabricating sports lighting and providing professional engineering services needed to assume engineering responsibility.

- 1. Engineering Responsibility: Preparation of delegated-design submittals and comprehensive engineering analysis by a qualified professional engineer.

- C. Luminaire Photometric Data Testing Laboratory Qualifications:

- 1. Luminaire manufacturers' laboratory accredited under the NVLAP for Energy Efficient Lighting Products.
 - 2. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

- D. Field Testing Agency Qualifications: An independent testing agency that is accredited under the NVLAP for Energy Efficient Lighting Products, a member company of NETA,

or an NRTL as defined in 29 CFR 1910.7, with the experience and capability to conduct field testing in accordance with IES LM-5.

- E. Foundation Testing Agency Qualifications: Qualified according to ASTM C1093.
- F. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 - 1. AWS D1.1/D1.1M.
 - 2. AWS D1.2/D1.2M.

1.13 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.
- B. Store poles on decay-resistant skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

PART 2 - PRODUCTS

2.1 SPORTS LIGHTING SYSTEM CONSTRUCTION

- A. Approved manufacturers include, but are not limited to Musco *(basis of design) and Ephesus.
- B. Manufacturing Requirements: All components shall be designed and manufactured as a system. All luminaires, wire harnesses, drivers and other enclosures shall be factory assembled, aimed, wired and tested.
- C. Durability: All exposed components shall be constructed of corrosion resistant material and/or coated to help prevent corrosion. All exposed carbon steel shall be hot dip galvanized per ASTM A123. All exposed aluminum shall be powder coated with high performance polyester or anodized. All exterior reflective inserts shall be anodized, coated, and protected from direct environmental exposure to prevent reflective degradation or corrosion. All exposed hardware and fasteners shall be stainless steel of 18-8 grade or better, passivated and coated with aluminum-based thermosetting epoxy resin for protection against corrosion and stress corrosion cracking. Structural fasteners may be carbon steel and galvanized meeting ASTM A153 and ISO/EN 1461 (for hot dipped galvanizing), or ASTM B695 (for mechanical galvanizing). All wiring shall be enclosed within the cross-arms, pole, or electrical components enclosure.
- D. System Description: Lighting system shall consist of the following:
 - 1. Galvanized steel poles and cross-arm assembly.
 - 2. Non-approved pole technology:
 - a. Square static cast concrete poles will not be accepted.

- b. Direct bury steel poles which utilize the extended portion of the steel shaft for their foundation will not be accepted due to potential for internal and external corrosive reaction to the soils and long term performance concerns.
- 3. Lighting systems shall use concrete foundations. See Structural Parameters in 2.3 for details.
 - a. For a foundation using a pre-stressed concrete base embedded in concrete backfill the concrete shall be air-entrained and have a minimum compressive design strength at 28 days of 3,000 PSI. 3,000 PSI concrete specified for early pole erection, actual required minimum allowable concrete strength is 1,000 PSI. All piers and concrete backfill must bear on and against firm undisturbed soil.
 - b. For anchor bolt foundations or foundations using a pre-stressed concrete base in a suspended pier or re-enforced pier design pole erection may occur after 7 days. Or after a concrete sample from the same batch achieves a certain strength.
- 4. Manufacturer will supply all drivers and supporting electrical equipment
 - a. Remote drivers and supporting electrical equipment shall be mounted approximately 10 feet above grade in aluminum enclosures. The enclosures shall be touch-safe and include drivers and fusing with indicator lights on fuses to notify when a fuse is to be replaced for each luminaire. Disconnect per circuit for each pole structure will be located in the enclosure. Integral drivers are not allowed.
 - b. Manufacturer shall provide surge protection at the pole equal to or greater than 40 kA for each line to ground (Common Mode) as recommended by IEEE C62.41.2_2002.
- 5. Wire harness complete with an abrasion protection sleeve, strain relief and plug-in connections for fast, trouble-free installation.
- 6. All luminaires, visors, and cross-arm assemblies shall withstand 150 mph winds and maintain luminaire aiming alignment.
- 7. Control cabinet to provide remote on-off control, monitoring, and entertainment features of the lighting system. See Section 2.3 for further details.
- 8. Contactor cabinet to provide on-off control.
- 9. Manufacturer shall provide lightning grounding as defined by NFPA 780 and be UL Listed per UL 96 and UL 96A.
 - a. Integrated grounding via concrete encased electrode grounding system.

- b. If grounding is not integrated into the structure, the manufacturer shall supply grounding electrodes, copper down conductors, and exothermic weld kits. Electrodes and conductors shall be sized as required by NFPA 780. The grounding electrode shall be minimum size of 5/8 inch diameter and 8 feet long, with a minimum of 10 feet embedment. Grounding electrode shall be connected to the structure by a grounding electrode conductor with a minimum size of 2 AWG for poles with 75 feet mounting height or less, and 2/0 AWG for poles with more than 75 feet mounting height.

E. Safety: All system components shall be UL listed for the appropriate application.

2.2 EMERGENCY EGRESS LIGHTING

A. Egress Lighting: In case of power failure, provide a minimum of 1.0-fc (10.8-lux) illumination, within 30 seconds, measured at grade in spectator and spectator egress areas.

- 1. Duration of emergency illumination shall be not less than 90 minutes.

2.3 ELECTRICAL

A. Electric Power Distribution Requirements:

- 1. Electric Power: 480 V; three phase.
 - a. Balance load between phases. Install wiring to balance three phases at each support structure.
 - b. Include required overcurrent protective devices and individual lighting control for each sports field or venue.
- 2. Maximum total voltage drop: Voltage drop to the disconnect switch located on the poles shall not exceed three (3) percent of the rated voltage.

B. Energy Consumption: The kW consumption for the field lighting system shall not exceed.

2.4 CONTROL

- A. Instant On/Off Capabilities: System shall provide for instant on/off of luminaires.
- B. Lighting contactor cabinet(s) constructed of NEMA Type 4 aluminum, designed for easy installation with contactors, labeled to match field diagrams and electrical design. Manual off-on-auto selector switches shall be provided.
- C. Dimming: System shall provide for 3-stage dimming (high-medium-low). Dimming with be set via scheduling options (Website, app, phone, fax, email).

- D. Remote Lighting Control System: System shall allow owner and users with a security code to schedule on/off system operation via a web site, phone, fax or email up to ten years in advance. Manufacturer shall provide and maintain a two-way TCP/IP communication link. Trained staff shall be available 24/7 to provide scheduling support and assist with reporting needs.

The owner may assign various security levels to schedulers by function and/or fields. This function must be flexible to allow a range of privileges such as full scheduling capabilities for all fields to only having permission to execute “early off” commands by phone. Scheduling tool shall be capable of setting curfew limits.

Controller shall accept and store 7-day schedules, be protected against memory loss during power outages, and shall reboot once power is regained and execute any commands that would have occurred during outage.

- E. Remote Monitoring System: System shall monitor lighting performance and notify manufacturer if individual luminaire outage is detected so that appropriate maintenance can be scheduled. The controller shall determine switch position (manual or auto) and contactor status (open or closed).

- F. Management Tools: Manufacturer shall provide a web-based database and dashboard tool of actual field usage and provide reports by facility and user group. Dashboard shall also show current status of luminaire outages, control operation and service. Mobile application will be provided suitable for IOS, Android and Blackberry devices.

Hours of Usage: Manufacturer shall provide a means of tracking actual hours of usage for the field lighting system that is readily accessible to the owner.

1. Cumulative hours: shall be tracked to show the total hours used by the facility.
2. Report hours saved by using early off and push buttons by users.

- G. Communication Costs: Manufacturer shall include communication costs for operating the control and monitoring system for a period of 10 years.

- H. Communication with luminaire drivers: Control system shall interface with drivers in electrical components enclosures by means of powerline communication.

2.5 STRUCTURAL PARAMETERS

- A. Wind Loads: Wind loads shall be based on the 2018 International Building Code. Wind loads to be calculated using ASCE 7-10, an ultimate design wind speed of 115 and exposure category C.
- B. Pole Structural Design: The stress analysis and safety factor of the poles shall conform to latest AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (LTS-6).
- C. Foundation Design: The foundation design shall be based on soil parameters as outlined in a future geotechnical report. If no geotechnical report is available, the foundation design shall be based on soils that meet or exceed those of a Class 5 material as defined by 2018 IBC Table 1806.2.

- D. Foundation Drawings: Project specific foundation drawings stamped by a registered engineer in the state where the project is located are required. The foundation drawings must list the moment, shear (horizontal) force, and axial (vertical) force at ground level for each pole. These drawings must be submitted at time of bid to allow for accurate pricing.

2.4 LUMINAIRES, LAMPS, AND BALLASTS

- A. Luminaires: Complying with requirements described in Section 265619 "Exterior Lighting."
 - 1. Listed and labeled, by an NRTL acceptable to authorities having jurisdiction, for compliance with UL 1598 for installation in wet locations.
 - 2. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without using tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent their accidental falling during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lens. Designed to disconnect ballast when door opens.
 - 3. Exposed Hardware: Stainless steel latches, fasteners, and hinges.
 - 4. Spill-Light Control Devices: Internal louvers and external baffles furnished by manufacturer and designed for secure attachment to specific luminaire.
 - 5. Luminaires shall be bracket-mounted, full-cutoff type with integral drivers.
 - 6. Lamps for Luminaires: LED.

2.5 POWER DISTRIBUTION AND CONTROL

- A. Wiring Method for Feeders, Subfeeders, Branch Circuits, and Control Wiring: Underground nonmetallic raceway; No. 10 AWG minimum conductor size for power wiring.
- B. Overhead-, pole-, or structure-supported wiring and transformers are not permitted.
- C. Electrical Enclosures Exposed to Weather: NEMA 250, Type 4X enclosure constructed from stainless steel, with hinged doors fitted with padlock hasps or lockable latches.

2.6 POLE AND BASE PROTECTION

- A. Pole Pads: Wraparound pad, with 4 inches (100 mm) of extra-firm polyfoam, 360-degree coverage of ground-mounted poles and supports, continuous hook-and-loop fastening; and not less than 72 inches (1820 mm) high.

2.7 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.8 MAINTENANCE MATERIAL ITEMS

- A. Spare Parts: Furnish to Owner spare parts, for repairing sports lighting, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
 - 1. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One percent of each type and rating installed. Furnish at least one of each type.
 - 2. Ballasts: One percent of each type and rating installed. Furnish at least one of each type.
 - 3. Fuses: 10 percent of each type and rating installed. Furnish at least one of each type.

PART 3 - EXECUTION

3.1 SOIL QUALITY CONTROL

- A. It shall be the Contractor's responsibility to notify the Owner if soil conditions exist other than those on which the foundation design is based, or if the soil cannot be readily excavated. Contractor may issue a change order request / estimate for the Owner's approval / payment for additional costs associated with:
 - 1. Providing engineered foundation embedment design by a registered engineer in the State of Maryland for soils other than specified soil conditions;
 - 2. Additional materials required to achieve alternate foundation:
 - 3. Excavation and removal of materials other than normal soils, such as rock, caliche, etc.

3.2 DELIVERY TIMING

- A. Delivery Timing Equipment On-Site: The equipment must be on-site six to eight weeks from receipt of approved submittals and receipt of complete order information.

3.3 FIELD QUALITY CONTROL

- A. Illumination Measurements: Upon substantial completion of the project and in the presence of the Contractor, Project Engineer, Owner's Representative, and Manufacturer's Representative, illumination measurements shall be taken and verified. The illumination measurements shall be conducted in accordance with IESNA LM-5-04.

- B. Field Light Level Accountability
- C. Light levels are guaranteed not to fall below the target maintained light levels for the entire warranty period of 10 years. These levels will be specifically stated as “guaranteed” on the illumination summary provided by the manufacturer.
 - 1. The contractor/manufacturer shall be responsible for conducting initial light level testing and an additional inspection of the system, in the presence of the owner, one year from the date of commissioning of the lighting.
 - 2. The contractor/manufacturer will be held responsible for any and all changes needed to bring these fields back to compliance for light levels and uniformities. Contractor/Manufacturer will be held responsible for any damage to the fields during these repairs.
- D. Correcting Non-Conformance: If, in the opinion of the Owner or his appointed Representative, the actual performance levels including footcandles and uniformity ratios are not in conformance with the requirements of the performance specifications and submitted information, the Manufacturer shall be required to make adjustments to meet specifications and satisfy Owner.

3.4 WARRANTY AND GUARANTEE

- A. 10-Year Warranty: Each manufacturer shall supply a signed warranty covering the entire system 10 years from the date of shipment. Warranty shall guarantee specified light levels. Manufacturer shall maintain specifically-funded financial reserves to assure fulfillment of the warranty for the full term. Warranty does not cover weather conditions events such as lightning or hail damage, improper installation, vandalism or abuse, unauthorized repairs or alterations, or product made by other manufacturers.
- B. Maintenance: Manufacturer shall monitor the performance of the lighting system, including on/off status, hours of usage and luminaire outage for 10 years from the date of equipment shipment. Parts and labor shall be covered such that individual luminaire outages will be repaired when the usage of any field is materially impacted. Manufacturer is responsible for removal and replacement of failed luminaires, including all parts, labor, shipping, and equipment rental associated with maintenance. Owner agrees to check fuses in the event of a luminaire outage.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

END OF SECTION

SECTION 27 05 00
TELECOMMUNICATIONS PATHWAYS AND SPACES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Telecommunications Room Build Out
- B. Pathways for Telecommunications Systems
- C. Grounding and Bonding for Telecommunications

1.02 References

- A. Industry Codes, Standards and Methods shall be observed, including the following:
 - 1. ANSI/TIA-568-C.0: Generic Telecommunications Cabling for Customer Premises.
 - 2. ANSI/TIA-568-C.1: Commercial Building Telecommunications Cabling Standard
 - 3. ANSI/TIA-568-C.2: Balanced Twisted Pair Cabling and Components Standard
 - 4. ANSI/TIA-568-C.3: Optical Fiber Cabling Components Standard
 - 5. ANSI/TIA-569-B: Commercial Building Standard for Telecommunications Pathways and Spaces
 - 6. ANSI/TIA-570-B: Residential Telecommunications Cabling Standard
 - 7. ANSI/TIA-606-A: Administration Standard for Telecommunications Infrastructure of Commercial Buildings
 - 8. ANSI-J-STD-607-D: Commercial Building Grounding and Bonding Requirements for Telecommunications
 - 9. ANSI/TIA-758-A: Customer-Owned Outside Plant Telecommunications Cabling Standard
 - 10. BICSI Telecommunications Distribution Methods Manual (TDMM), Latest Edition
 - 11. National Fire Protection Agency (NFPA-70): National Electrical Code (NEC)
- B. Comply with all local, state and federal codes for telecommunications installations.

1.03 System Description

- A. Design Requirements
 - 1. Contractors shall outfit all telecom rooms according to T Drawings. Termination and distribution fields shall be installed according to manufacturers' guidelines and industry standards.
 - 2. TR and TER layouts shall be approved by Technology personnel prior to installation of cabling, pathways or termination hardware.
- B. Performance Requirements

1. Materials and equipment will be installed in an orderly and precise manner. Clearances between equipment will prevent incidental damage or unsafe conditions.
2. Equipment shall provide proper support and housing of all intended active and non-active components.
3. Refer to Telecom Room Details for precise location of equipment and termination fields.

1.04 Submittals

A. Product Data

1. Provide product data for all equipment listed in Part 2
2. Equipment data must be submitted in a single package and clearly indicated for efficient review. (by specifications section) Equipment submittals not clearly called out will be rejected without question at the contractor's expense for resubmittal.
3. Product data must be approved by designer and owner prior to purchase and installation of equipment.
4. LEED Submittals
 - a. Product data for Credit IEQ 4.1: For adhesives and sealants applied within the building waterproofing envelope, documentation including printed statement of VOC content in g/L.
 - b. Product data for Credit IEQ 4.2: For paints and coatings applied within the building water proofing envelope, documentation including printed statement of VOC content in g/L.
 - c. Product data for Credit IEQ 4.4: For composite wood installed in the building interior as equipment backer boards, documentation indicating no added urea formaldehyde resins.

B. Shop Drawings

1. Provide scaled drawings to show proposed equipment locations, clearances and administrative labeling of Telecom Rooms and equipment. All fields, racks and cabinets shall be methodically documented and permanently labeled agreed upon by the school district.
2. Shop drawings must be approved by the designer and owner prior to purchase and installation of any equipment.

C. As-Built Drawings

1. The contractor shall upon completion of the project, provide a complete set of As-Built drawings. These drawings shall identify room numbers and outlet identification numbers for all low voltage cabling systems. Drawings should also include all IDF and MDF locations with a detailed layout of all racks, patch panels, trays, and wall fields.

2. Additional project information shall include Reline Details of all horizontal and backbone cable routes and pathways.
3. As-builts shall be submitted in electronic CAD format and in hardcopy at the end of the project.

1.05 Quality Assurance

A. Regulatory Requirements

1. All equipment shall be installed in a neat and professional manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the school district. Equipment and materials shall be of the quality and manufacturer indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Substitutions

1. Conditions for consideration of “Or Equal” Products: Where products are specified by name and accompanied by the term “or equal”, the proposed “or equal” product will be considered when the following conditions are satisfied.
 - a. If all the following conditions are not satisfied, the Design Consultant will return requests without action, except to record noncompliance with these requirements
 - b. Proposed product does not require extensive revisions to the Contract Documents.
 - c. With the exception of the product name or number and manufacturer’s name, proposed product conforms with requirements indicated on the Drawings and in the Specifications in every respect and will produce indicated results.
 - d. Proposed product is fully documented and properly submitted.
 - e. Proposed product is compatible with and has been coordinated with other portions of the Work.
 - f. Proposed product provides the specified warranty.
2. If the proposed product involves more than one contractor, proposed product has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
3. Submission is accompanied with detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
4. Submission is accompanied with a list of similar installations for completed projects with project names and addresses and names and addresses of design consultants and authorities, if requested.

5. Submission is accompanied with proposed product's Manufacturer signed written statement on Manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents.

1.06 Warranty

- A. Warranty: Installer must provide manufacturer's warranty without cost to the owner during that time period, including materials, hourly costs, etc.,.
- B. The installer's warranty shall guarantee workmanship for a period of two years, during which time any deficiency in installation shall be repaired or replaced at no additional cost to the school district. The contractor must respond within 2 business days of written notification.

PART 2 - PRODUCTS

2.01 Materials

- A. Adhesives, sealants, paints and coatings applied within the building waterproofing envelope: Comply with low-emitting requirements in Division 01 Section "Indoor Air Quality Requirements."
- B. Composite wood installed in the building interior as equipment backer boards: Contain no added urea formaldehyde resins.
- C. Ladder-Type Aluminum Cable Tray (Ladder Rack)
 1. All TR and TER locations shall receive ladder-rack style cable tray as shown in T-series drawings for cable distribution.
 2. Class 5160 or Chatsworth "TELCO-Style Cable Runway," 12-inch ladder rack from racks/cabinets from corridor or other wire routing space where indicated on drawings.
- D. J-Hooks
 1. J-Hooks shall be rated for low voltage cables.
 2. J-hooks shall be provided where cable tray and conduit are not present.
 3. J-hooks shall be installed on 5'-6' centers, not further apart.
- E. Conduit
 1. In-wall conduit shall be provided for work in new areas. Refer to T Drawings for conduit details.
 2. Conduit bend radii shall follow current ANSI/TIA standards for telecommunications.
 3. Refer to T drawings for locations and sizes of all sleeves for telecommunications.
- F. Gang Boxes
 1. In-wall Gang Boxes for low voltage
 - a. Single Gang Box: Minimum 2.75" wide X 3.75" high X 1.7" deep with 3/4" and 1" knockouts.

- b. In-wall Double Gang Box for low voltage: 4 Inch Back Knockout, 4 Inch Side Knockout, 4 Inch End Knockout, Length 3 3/4 Inches, Width 3 25/32 Inches, Depth 3 1/2 Inches or comparable.
 - 2. Extra Deep in-wall gang boxes
 - a. 3 3/4" Deep, 2 3/16" Wide, 3 7/8" High
 - b. 4 Knockouts, 2 Per End
 - G. Distribution Backboard
 - 1. Plywood
 - a. 3/4" AC-grade plywood shall be provided as shown on T drawing details to line the walls within the TR. The plywood should be provided in 4' x 8' sheets.
 - b. Plywood shall be void free and painted on all sides with two coats of fire-resistant paint.
 - H. Electrical Protection for Telecommunications
 - 1. Telecommunications Primary Bonding Busbar (PBB) and Telecommunications Secondary Bonding Busbar (SBB)
 - a. Provide one PBB in the Telecommunications Equipment Room as shown on T Drawings.
 - b. Provide a SBB in every Telecommunications Room and distribution cabinet location as shown on T Drawings.
 - c. The telecom grounding and bonding system shall be bonded to the main electrical ground for the facility.
 - I. Rack mounted power strip
 - 1. Provide one 10 port transient, surge protection strip (UL Listed) for each rack or cabinet.

PART 3 - EXECUTION

3.01 Examination

- A. Site Verification of Conditions
 - 1. Contractor shall ensure that sufficient space has been allocated for the installation of all equipment per T Drawings prior to Installation. Clearances and existing equipment should be taken into consideration. If insufficient space exists, the Design consultant should be notified in writing, before proceeding with Installation.

3.02 Installation

- A. Distribution Racks and Cabinets
 - 1. Racks shall be assembled such that mounting rails are exactly perpendicular to the base.

2. Racks shall be secured to the floor using appropriate anchors.
 3. Racks shall be grounded to the TGB or appropriate building ground using a minimum #6 grounding wire.
- B. Distribution Backboard
1. Securely fasten backboard to wall-framing members to ensure it can support attached equipment.
 2. Mount Plywood on all available areas where telecommunications equipment may be located.
 3. Refer to T Drawings for minimum coverage.
- C. Ladder Rack and Cable Tray
1. Ladder rack and cable tray shall be properly secured using manufacturer recommended anchors and connectors.
 2. Ladder rack and cable tray shall be routed according to T Drawing floor plans.
 3. Ladder rack and cable tray shall be bonded to ground according to ANSI/TIA 607.
- D. Firestop
1. Provide re-enterable, non-hardening, intumescent putty, rated for floors or wall, UL approved assembly, with approved packing material for fire stopping inside building cable penetrations thru conduits sleeves.
 2. The material used for sealing all openings shall have a fire rating equal to or greater than the floor ceiling, wall or partition material.
- E. Sleeves and openings
1. The telecommunications contractor shall provide sleeves through all walls and floors to protect cabling and or raceways installed as part of the telecommunications system. All sleeves shall extend through the respective wall or partition and finish with a connector protective bushing.
 2. Sleeves through all fire rated structures shall have the appropriate fire stop system.

END OF SECTION

**SECTION 27 10 00
STRUCTURED CABLING**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Local Area Network (LAN) Cabling
- B. Telephone Cabling
- C. Coaxial Cabling
- D. Termination Equipment for Telecommunications
- E. Faceplates and Outlets

1.02 DEFINITIONS

- A. “Backbone Cabling” refers to telecommunications cabling that provides interconnections between telecommunications rooms, equipment rooms, and entrance facilities.
- B. “Communications Network Outlet (CNO)” refers to a collection of one or more mechanical cable termination device for horizontal cable in the work area.
- C. “Drop” refers to the vertical transition to a location of one or more CNOs.
- D. “Horizontal Cabling” refers to the cabling between and including the work area communications network outlet and the horizontal cross-connect in the telecommunications room.
- E. “Jack” refers to a female-style telecommunication receptacle.
- F. “Telecom Room (TR)” refers to an enclosed space for housing telecommunications equipment, cable terminations, and cross-connects. The room is the recognized cross-connect between the backbone or trunk cabling and horizontal cabling.
- G. “Telecom Equipment Room (TER)” refers to a centralized space for telecommunications equipment that serves the occupants of the building, usually containing the headend equipment for the distribution systems found in the building.

1.03 REFERENCES

- A. Industry Codes, Standards and Methods shall be observed, including the following:
 - 1. ANSI/TIA-568.0-E: Generic Telecommunications Cabling for Customer Premises
 - 2. ANSI/TIA-568.1-E: Commercial Building Telecommunications Cabling Standard
 - 3. ANSI/TIA-568.2-D: Balanced Twisted Pair Cabling and Components Standard
 - 4. ANSI/TIA-568.3-D: Optical Fiber Cabling Components Standard
 - 5. ANSI/TIA-569-E: Commercial Building Standard for Telecommunications Pathways and Spaces
 - 6. ANSI/TIA-606-C: Administration Standard for Telecommunications Infrastructure of Commercial Buildings
 - 7. ANSI/TIA-607-D: Commercial Building Grounding and Bonding Requirements for Telecommunications
 - 8. ANSI/TIA-758-B: Customer-Owned Outside Plant Telecommunications Cabling Standard
 - 9. BICSI Telecommunications Distribution Methods Manual (TDMM), Latest Edition
 - 10. National Fire Protection Agency (NFPA-70): National Electrical Code (NEC)
- B. Comply with all local, state and federal codes for telecommunications installations.

1.04 SYSTEM DESCRIPTION

STRUCTURED CABLING

Bid Pack E – Fieldhouse, Athletic Fields and Storage Buildings

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IFB - 11/04/25

A. Design Requirements

1. All systems and equipment must comply with the Delaware State-Wide Information Technology and Architecture Standards, Latest Version.
2. LAN and Telephone Distribution:
 - a. Provide labor, materials, equipment, services and operations required for complete installation of LAN compatible with:
 - i. Ethernet 100Base-FX
 - ii. Ethernet 1000Base-SX
 - iii. Ethernet 1000Base-LX
 - iv. Ethernet 10GBase-S
 - v. Ethernet 10Base-LX4
 - vi. Ethernet 10GBase-L
 - vii. Ethernet 10GBase-LRM
 - viii. Fibre Channel 100-MX-SN-I
 - ix. Fibre Channel 100-SM-LC-L
 - x. Fibre Channel 200-MX-SN-I
 - xi. Fibre Channel 200-SM-LC-L
 - xii. Fibre Channel 400-MX-SN-I
 - xiii. Fibre Channel 400-SM-LC-L
 - xiv. Fibre Channel 1200-MX-SN-I
 - xv. Fibre Channel 1200-SM-LL-L
 - xvi. FDDI PMD ANSI X3.166
 - xvii. FDDI SMF-PMD ANSI X3.184
 - b. All wiring including copper and fiber optic employs a star topology.
 - i. Category 6/6a UTP wiring terminates on Category 6/6a RJ-45 jack at workstation and on Category 6 rack-mounted patch panel in telecommunications room. Connections wired per ANSI/TIA-568A.
 - ii. Multi-strand composite fiber optic cable connects distribution racks between telecommunications rooms and terminates on rack-mounted fiber optic patch panel.
 - c. Network cables routed from distribution racks throughout the building as shown on T-Drawings. Drop to outlet installed in conduit and wall box, to communications outlet in classrooms, offices, or other locations indicated on T-Drawings.

- i. Refer to notes on each drawing to determine exact installation methods.
 - ii. Note and record all cable lengths to the nearest foot.
 - iii. Replace any cable exceeding 90 meters (295 feet) and route to reduce length to a minimum of 90 meters. Complete all cable rerouting for compliance at no additional cost to School district.
 - iv. Identify to the Design consultant prior to installation of any cables that cannot be reduced to 90 meters or less in total length (rise and run).
 - v. Strictly adhere to most current versions of ANSI/TIA Telecommunications cabling standards.
 - vi. Unless otherwise noted on T-Drawings, provide ladder-type cable tray from corridor to distribution racks and termination fields in telecommunication rooms.
 - vii. Install “waterfall” device providing sweep from cable tray to data rack/cabinet and other vertical transitions.
 - d. Data and Telephone outlets: Category 6/6A rated RJ-45 type connectors with all four copper pairs terminated and tested in accordance with the 568B wiring standard.
 - e. Fiber Optic Horizontal and Backbone Cables: Terminate on panels in each rack and connectors with ceramic sleeves. Terminate and test all strands unless otherwise noted.
 - f. Permanently identify and label all cables and termination devices, at distribution rack and workstation in accordance with ANSI TIA 606 Standard or as agreed by Design consultant and school district.
 - g. Remove and replace any cables failing to meet end-to-end testing requirements; do not abandon cable in place. All cable shall be terminated at both ends, unless noted in T-Drawings.
- B. Performance Requirements
- 1. Comply with applicable requirements in Local, State and Federal Codes, ANSI/TIA Standards, and BICSI methodology.

1.05 SUBMITTALS

- A. Comply with the requirements of Division 0 and Division 1 - Submittals and as modified below.
- B. Product Data: Submit manufacturer’s product literature, technical specifications and similar information for the following items demonstrating compliance with the specified requirements.
 - 1. Communications outlets, faceplates, and accessories.
 - 2. Fiber optic cable, patch cables and terminations.
 - 3. Copper cable, patch cables and termination devices.
 - 4. Rack configurations and wiring diagrams.
 - 5. Network cabling test equipment and process (routines).
 - 6. Equipment Racks
 - 7. Outlets

- C. Samples:
 - 1. Provide samples of outlets and assemblies as described below, prior to installation, for approval by designer.
 - 2. Telecommunications outlets – Submit samples of telecommunications outlets to be provided including following components and characteristics:
 - a. Flush mounted and Raceway outlets – Completely assembled faceplate and wall box with each type of outlet to be mounted in faceplate, including blank covers, dust covers, labeling field, cabling, and adapter plates and bezels required.
 - b. Sample characteristics:
 - i. Provide all components in colors selected by the Design consultant.
 - ii. Provide multiple outlet samples where required to accurately represent the range of outlets to be provided.
- D. Shop Drawings
 - 1. The Contractor shall submit floor plan and wiring detail shop drawings of all systems showing all components of the systems. Submit wiring diagrams showing connections for all systems and equipment.
- E. Quality Control Submittal
 - 1. Test Reports: Submit complete sample test data and reports with exact labels used on cables, patch panels and faceplates.
 - 2. Certificates
 - a. Manufacturer Certification: Submit certification from manufacturer of products to be installed under this contract certifying that Installer is authorized by manufacturer to install specified products.
 - b. Installer Experience Listing: Submit list of at least 5 completed projects as specified below in “Quality Assurance – Qualifications – Installer.”
- F. Contract Closeout Submittal: Comply with requirements of Division 0, including submission of operating and maintenance instructions as item in “Operation and Maintenance Data” manual described in that Section.

1.06 QUALITY ASSURANCE

- A. All Work shall be installed in a first class, neat and workmanlike manner by skilled Technicians. The quality of the workmanship shall be subject to inspection and approval by authorized school district personnel. Any work found to be of inferior quality and/or workmanship shall be replaced and/or reworked until the approval of the school district is obtained.
- B. Installer Qualifications: Qualified to cable, terminate and test data network cabling system specified in this Section, certified by manufacturer of products to be installed, and completed at least 5 computer network installations of similar size, nature and complexity as specified for this project.
- C. Conditions for Consideration of "Or Equal" Products: Where products are specified by name and accompanied by the term "or equal", the proposed "or equal" product will be considered when the following conditions are satisfied. If all the following conditions are not satisfied, the Design Consultant will return requests without action, except to record noncompliance with these requirements:
 - 1. Proposed product does not require extensive revisions to the Contract Documents.

2. With the exception of the product name or number and manufacturer's name, proposed product conforms with requirements indicated on the Drawings and in the Specifications in every respect and will produce indicated results.
3. The proposed product is fully documented and properly submitted.
4. The proposed product has received necessary approvals of authorities having jurisdiction.
5. The proposed product is compatible with AND has been coordinated with other portions of the Work.
6. Proposed product provides the specified warranty.
7. If the proposed product involves more than one contractor, the proposed product has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
8. The submission is accompanied with detailed comparison of significant qualities of the proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
9. The submission is accompanied with a list of similar installations for completed projects with project names and addresses and names and addresses of design consultants and authorities, if requested.
10. The submission is accompanied with the proposed product's Manufacturer signed written statement on Manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents.

1.07 WARRANTY

- A. Installer's Warranty: Provide manufacturer's system warranty against electrical or mechanical defects for two years from the date of final acceptance.
- B. A fifteen (15) year Extended Product Warranty and Systems Assurance Warranty for this wiring system shall be provided by the Manufacturer as follows:
 1. Extended Product Warranty: The Extended Product Warranty shall ensure against product and workmanship defects, that all approved cabling components exceed the specifications of ANSI/TIA 568B and Addenda for fiber link/channels and copper components, for a fifteen (15) year period. The warranty shall apply to all passive components, including both cable and connecting hardware as a combined system. Any claims cover replacement costs on any defective product, both material and labor. Extended warranties beyond fifteen (15) years will be considered.
 2. System Assurance: The System Assurance shall cover the failure of the wiring system to support the application which it was designed to support as well as additional application(s) introduced in the future by recognized standards or user forums that use the ANSI/TIA 568B component and link/channel specifications for cabling, for a fifteen (15) year period.
 3. System Certification: Upon successful completion of the installation and subsequent inspection, the school district shall be provided with a numbered certificate, from the manufacturing company, registering the installation.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials shall be new and unused.
- B. All cables shall be plenum rated.

- C. System wiring and equipment installation shall be in accordance with good engineering practices as established by ANSI/TIA and the NEC. Wiring shall meet all state and local electrical codes. All wiring shall test free from all grounds and shorts.
- D. Velcro straps shall be used for bundling wires. Wires shall be bundled loosely. Permanent cable ties are not acceptable.
- E. The wiring system shall consist of the following:
 - 1. Accessories and Appurtenances
 - 2. Cable Management Devices
 - 3. Fiber Optic Cable and Terminators (as indicated on drawings)
 - 4. Copper and Fiber Patch cables
 - 5. Remote Jacks
 - 6. Termination/Patch Panels
 - 7. Twisted Pair Data Cables
 - 8. The Cable Infrastructure Project requires a structured cabling system, or equivalent single-manufacturer solution. The Category 6/6a portion of the cabling system shall comply with the link and channel performance requirements of ANSI/TIA for 4-pair 100 Ohm Category 6/6a Cabling”. The cabling system shall be backed by a 15-Year System Warranty.
 - 9. The work includes the provision for a complete and operable Local Area Network Building Data System consisting of active and non-active components. The cabling system and all wiring components shall meet and comprise an ANSI/TIA Category 6/6a Wiring System. With master and remote data equipment the completed system shall provide 1Gbs Fiber Optic Fast Ethernet communications backbone support to the edge switches and Ethernet 1000 BASE-T to the workstation data jacks. The system shall provide services such as computer networking, data transmission, graphics and other multi-media offerings.
 - 10. Provide one home run cable from each data/voice jack to appropriate wiring closet.
 - 11. The cable length of home run cable shall not exceed 90 meters.
 - 12. All Modular jack panels shall be wired to ANSI/TIA 568B.

2.02 J-HOOKS

- A. Cooper B-Line BCM-21, 23 or 64.
 - 1. Provide in sufficient quantity for 15% future expansion.
 - 2. Installed no more than 6’ apart.
 - 3. Install in any area without cable tray above false ceilings.

2.03 RACKS / CABINETS

- A. Distribution Racks and Cabinets
 - 1. Wall-Mounted Equipment Cabinet
 - a. Hubbell Quad Cab with window door, exhaust fan kit and filter kit.
 - b. 24” X 36”
 - 2. Remote Equipment Box
 - a. Hubbell Rebox RE4X

3. All racks and cabinets shall be capable of supporting the weight and space of existing and proposed equipment. 30% growth capacity shall be provided in addition to detailed requirements.
4. Racks, cabinets and other termination equipment shall be properly secured to the floor with appropriate anchors and bonded to Telecommunications Grounding System.

B. Cable Management

1. Horizontal Cable Management

- a. Horizontal wire management panels are required for patch panels in certain racks. (See drawings for rack diagrams.)
- b. Horizontal cable management shall occupy 1 or 2 rack units, as shown on T Drawings.
- c. Similar to OR-MM6HMF1RU
 - i. or approved equivalent

C. Vertical Cable Management

- a. Vertical Cable management shall be provided for all racks. Provide 2 for each rack or cabinet.
- b. Cable management shall be – Ortronics OR-60400510
- c. Or approved equivalent.

D. Electrical Protection for Telecommunications

1. Telecommunications Grounding Busbars

- a. Each rack/cabinet shall have a horizontal or vertical rack/cabinet grounding busbar and shall be bonded to the grounding system.
- b. The telecom grounding and bonding system shall be bonded to the main electrical ground for the facility.

2.04 HORIZONTAL CABLES

A. Category 6a 100-ohm UTP 23 AWG Wireless cables shall have a distinctive color. Submit for approval from design team.

1. Hubbell C6ASxx
2. Or approved equal from
 - a. Belden
 - b. Berk-Tek
 - c. Systimax

B. Category 6 100-ohm UTP Voice, Data, Wireless and Security cables shall each have a distinctive color. Submit for approval from design team.

1. Hubbell HC6RPExx
2. Hubbell HC6RRxx
3. Hubbell C6SOPBK
4. Or approved equal from
 - a. Hitachi
 - b. Belden
 - c. Berk-Tek
 - d. Systimax

2.05 BACKBONE CABLES

- A. SingleMode Fiber Optic Cables
 - 1. 12 Strand Hitachi 61459
 - 2. Or approved equal from
 - a. Corning
 - b. Berk-Tek
 - c. Hubbell

2.06 TERMINATION FIELDS

- A. Category 6a 48-Port Patch Panels. Patch panels shall be segregated for POE switches and non-POE switches.
 - 1. Provide 15% spare capacity
 - 2. Hubbell HP6A48
 - 3. Hubbell Rear Cable Manager
 - 4. Or approved equal from
 - a. Ortronics
 - b. Panduit
 - c. Systimax
 - d. Leviton
- B. Category 6 48-Port Patch Panels. Patch panels shall be segregated for POE switches and non-POE switches.
 - 1. Provide 15% spare capacity
 - 2. Hubbell P6E48U
 - 3. Hubbell PCBLMGT Rear Cable Manager
 - 4. Or approved equal from
 - a. Ortronics
 - b. Panduit
 - c. Systimax
 - d. Leviton
- C. Fiber Enclosure
 - 1. Hubbell 2U FCR350SP36R
 - 2. Hubbell 2U FCR350SP54R
 - 3. Hubbell 3U FCR525SPR
 - 4. Hubbell 4U FCR700SP
 - 5. Or approved equal from
 - a. Ortronics
 - b. Panduit
 - c. Systimax
 - d. Leviton
- D. Fiber Adaptor Panels
 - 1. Hubbell FSPLCDM6AQ
 - 2. Hubbell FSPLCQM6AQ
 - 3. Hubbell FSPLCDS6
 - 4. Hubbell FSPLCQS3
 - 5. Or approved equal from
 - a. Ortronics
 - b. Panduit
 - c. Systimax
 - d. Leviton
- E. Fiber Connector

1. Hubbell FCLC900K50GM12 9/125 UPC
2. Or approved equal from
 - a. Ortronics
 - b. Panduit
 - c. Systimax
 - d. Leviton

2.07 OUTLETS

- A. Category 6a Wireless Jacks
 1. Hubbell HJ6Axx (replace xx with specified colors)
 2. Or approved equal from
 - a. Ortronics
 - b. Panduit
 - c. Systimax
 - d. Leviton
- B. Category 6 Voice and Data Jacks
 1. Hubbell HXJ6xx (replace xx with specified colors)
 2. Or approved equal from
 - a. Ortronics
 - b. Panduit
 - c. Systimax
 - d. Leviton
- C. Faceplates
 1. Grommeted Opening
 2. Brushed Opening
 3. Hubbell IFP11xx
 4. Hubbell IFP12xx
 5. Hubbell IFP13xx
 6. Hubbell IFP14xx
 7. Hubbell IFP16xx
 8. Hubbell IFP26xx
 9. Hubbell IFP29xx
 10. Hubbell IFP212xx
 11. Or approved equal from
 - a. Ortronics
 - b. Panduit
 - c. Systimax
 - d. Leviton
- D. Frames
 1. Hubbell ISF2xx
 2. Hubbell ISF3xx
 3. Hubbell ISF4xx
 4. Hubbell ISF6xx
 5. Hubbell NS620xx
 6. Or approved equal from
 - a. Ortronics
 - b. Panduit
 - c. Systimax
 - d. Leviton

2.08 PATCH CORDS

- A. Cat 6a UTP Copper Patch Cords
 - 1. Hubbell HC6Axx03
 - 2. Hubbell HC6Axx05
 - 3. Hubbell HC6Axx07
 - 4. Hubbell HC6Axx010
 - 5. Hubbell HC6Axx15
 - 6. Hubbell HC6Axx20
 - 7. Hubbell HC6Axx25
 - 8. Or approved equal from
 - a. Ortronics
 - b. Panduit
 - c. Systimax
 - d. Leviton
- B. Cat 6 UTP Copper Patch Cords
 - 1. Hubbell HC6xx03
 - 2. Hubbell HC6xx05
 - 3. Hubbell HC6xx07
 - 4. Hubbell HC6xx010
 - 5. Hubbell HC6xx15
 - 6. Hubbell HC6xx20
 - 7. Hubbell HC6xx25
 - 8. Or approved equal from
 - a. Ortronics
 - b. Panduit
 - c. Systimax
 - d. Leviton
- C. Fiber Patch Cords
 - 1. Hitachi Singlemode
 - 2. Or approved equal from
 - a. Ortronics
 - b. Panduit
 - c. Systimax
 - d. Leviton

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine conditions under which telecommunications cabling and equipment and related components are to be installed in coordination with Installer of materials and components specified in this Section and notify affected Prime Contractors and Design consultant in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected to ensure a safe and timely installation.
 - 1. When the installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Design consultant written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

2. Visit Site to identify and become familiar with existing field conditions and specific requirements of each Site.
3. Verify all dimensions in the field and confirm the condition of existing hardware to be utilized.
4. Confirm space requirements and physical confines of all work areas to ensure that all materials can be installed in indicated spaces.
5. Confirm all outlet locations and cable pathways and advise the Design consultant in writing of any discrepancies or issues in Design described in Contract Documents.

3.02 PREPARATION

- A. Protection: Provide adequate protection of equipment and hardware before and after installation.
- B. Existing Communications Services: Ensure all telecommunications systems (voice, video and data) remain operational throughout the project.
 1. Identify any additional telecommunications outlets, circuits, and wiring at the site not shown on T-Drawings and interfering with installation of specified equipment.
 2. Contact local telephone, network and CATV company to identify all circuits providing existing services.
 3. Remove all accessible portions of abandoned communications cabling per NEC 800.52. Tag all communications cabling not terminated at both ends but retained for future use.

3.03 INSTALLATION

- A. Distribution Racks and Cabinets
 1. Racks shall be assembled such that mounting rails are exactly perpendicular to the base.
 2. Racks shall be secured to the floor using appropriate anchors.
 3. Racks shall be grounded to the PBB/SBB or appropriate building ground using a minimum #6 grounding wire.
- B. Provide and install all components necessary to install complete telecommunications cabling and equipment systems, including (but is not limited to) connectors, patch cables, terminators, etc...
 1. Cable runs shall be continuous and unbroken from end to end. Splicing of any Telephone, LAN, or coaxial video distribution cable is prohibited. Horizontal cabling for LAN and telephone shall end in rack-mounted patch panels.
 2. Secure all horizontal cables within ceiling cavities to the building structure.
 3. Loosely bundle all cables and support from structure at unequal intervals from 5 to 6 feet with spring steel fasteners and cable clip rated for use with high performance cables where cable tray or other support structure has not been provided as indicated on Drawings. All mounting clips shall be seismic type as per BOCA.
 4. Do not violate manufacturers' recommended loadings. Leave 30% capacity for future use of pathway.
 5. Verify all horizontal cable run lengths prior to installation. Re-distribute horizontal cabling to maintain distance requirements and maintain pathway route accessibility.
 6. Do not support cables from ceiling grid T-Bars, grid wire supports or bridle rings. Do not allow cables to touch the ceiling grid.

7. Do not secure cables with permanent cable ties. Do not tighten cable bundles in such a way as to cause jacket deformation or damage.
8. Provide a 10-foot service loop in all fiber optical cables to permit future cable splice and repair at all building entrance points and termination points.
9. Place cables in compliance with ANSI/TIA-568.B standards and BICSI recommended methods.
10. Tight 90-degree bends are unacceptable, and use of plastic “cinch-type” tie-wraps are not permitted, in order to prevent damage to cable jacket and compromise the cable’s electrical or optical characteristics.
11. Cable bundles shall be neatly routed with a service loop to provide 10 feet of slack at the cross-connect end and as noted in the T-drawings. Cable bundles shall be secured using only black Velcro cable wraps.
12. 3 feet of service loop shall be provided in the ceiling at each workstation. Contractors shall not secure service loop in coils, but route in such a manner as to minimize EMI.
13. Wireless outlet locations
 - a. Wireless locations shown on T-series drawings shall be installed outside of a faceplate.
 - b. The ceiling shall be marked and as-builts shall reflect the location of all terminated ends and service loops as directed by SCHOOL DISTRICT personnel.
 - c. Cable shall be terminated in a female RJ-45 female jack and left with a service loop as described in T-series drawings. Cables shall be tested and documented per previous requirements.
 - d. After completion of wireless site survey, outlet shall be re-terminated for connection to Wireless Access Point.

C. Determine allowable cable proximity to other electrical power sources of 480 Volts or less using ANSI/TIA-569A “Cabling Pathway Standard” for UTP cable separations from sources of EMI:

1. Minimum separation distance from Power Source at 480 V or less:

CONDITION	<u>< 2kVA</u>	<u>2-5 kV</u>	<u>> 5 kVA</u>
a. Unshielded power lines or electrical equipment in proximity to open or non-metal pathways	6 in.	12 in.	24 in.
b. Unshielded power lines or electrical equipment in proximity to open or non-metal pathways	3 in.	6 in.	12 in.
c. Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to grounded metal conduit pathway	3 in.	6 in.	12 in.
d. Transformers & Elec. Motors	40 in.	40 in.	40 in.
e. Fluorescent Lighting	12 in.	12 in.	12 in.

- D. Interior Fiber Optical Cable Installation Requirements
 - 1. Install all outdoor rated communications cables not rated for plenum placement in interior environments in metallic conduit, according to NEC Articles 770 and 800.
 - 2. Install Max Cell for fiber optic cabling in all conduits, as necessary for proper support of cables, or where required to assure pull-in tension not exceeding manufacturer's recommendations.
 - 3. Provide pull strings or ropes in all conduits used for communications cables.
- E. Cabling System
 - 1. Where not provided as part of the electrical work or the data/voice work, the Contractor shall furnish and install necessary conduit, raceways, pull boxes, outlet boxes and cable to provide a complete system as herein specified. All wiring shall be tested for continuity and freedom of all grounds and short-circuits. All outlet boxes shall be as specified for other wiring devices; size as required by the equipment manufacturer.
 - 2. Cables shall be installed in raceways or EMT, as detailed on the drawings and/or as specified above non-accessible ceilings, where exposed, and wherever it may be subject to physical damage. Where not provided as part of the electrical work or the data/voice work, the Contractor shall provide a raceway (conduit) from each outlet to above the accessible ceiling. Otherwise, cables shall be installed above accessible suspended tile ceilings and attached to building structure with approved bridle rings or J-hooks, cable is not permitted to rest on ceiling. The cable routes used shall avoid steam lines, power wiring and other utilities that may adversely affect the system's performance or result in damage to the cable. If the routes required place the cable in proximity to these utilities, the cable shall be suitably protected. Under no circumstances shall cable be run in hangers used for pipes or electric conduits nor shall the cable be supported in any way by attachment to these pipes, conduits or ceiling hangers.
 - 3. During the installation work, improper bending, stretching, twisting, kinking, pinching or any other improper handling must not deform the cable. All cable runs shall contain "S" loops or other means to accommodate expansion and contraction. Coaxial cables shall not bend at any point of installation to a radius of less than ten times the diameter of the cable or less than the value recommended by the cable manufacturer. A cable connected to electronic equipment in the system shall be tagged to show its function and the location of its other end. All labels shall be of durable material and securely fastened to the cable.
 - 4. All cables shall be fastened securely with suitable hardware so as to avoid sharp bends and to prevent rubbing against sharp corners and in a manner to prevent injury or physical distortion.
 - 5. Wiring for all wall-mounted equipment shall be concealed in raceway (conduit) from outlet to above removable ceilings, unless noted otherwise.
 - 6. Wiring installed above removable ceilings shall be installed on bridle rings. No cables shall be installed on the roof or exterior of the building.
 - 7. Infrastructure properly terminated on backboard, neatly arranged in orderly fashion and accurately identified.
 - 8. Equipment cabinet(s) anchored to wall or floor utilizing an approved method.
 - 9. Install all exposed cabling in surface raceway by Wiremold, Hubbell or Panduit where in-wall conduit has not been provided. Follow all manufacturers' guidelines requirements regarding bending radius and slack. All bends, offsets and fittings shall be appropriately sized to provide 30% capacity after installation.

- F. Install all cables in accordance with National, state and local codes and ANSI/TIA Standards, and BICSI methods.
 - 1. Follow manufacturer’s guidelines and requirements for all cable termination.
 - 2. Install and connect #6 AWG to bond all equipment racks, conduits and cable trays to the busbar in each telecom room. Each telecom room shall be interconnected to TER with #3 AWG bonding backbone to PBB per Telecommunications Grounding Diagram. It shall be left to licensed electricians to interconnect PBB with the lowest point of building ground. The contractor shall verify PBB has been bonded to building ground before declaring completion.
- G. Permanently identify all system components following ANSI/TIA-606A “Administration Standard for Commercial Telecommunications Infrastructure” with identification format:
 - 1. Identification: Provide permanent identification labels for outlets, faceplates, patch panels, access panels and entrance facilities.
 - 2. Each individual cable shall be labeled on both ends of cable terminations regardless of cable intended use. Labels must be machine printed with permanent black ink on laminated white label material. Contractors must check with appropriate school district personnel for appropriate labeling scheme. The intended format and labeling material must be approved by the school district Technology Department before labeling begins.

3.04 TESTING

- A. LAN and Telephone
 - 1. Upon completion of work, all parts of the telecommunications installation shall be tested by the Telecommunications Contractor and demonstrated free of any defects. Preliminary testing will be permitted but shall not be accepted in lieu of obtaining final test results. Final test results shall be accomplished by the use of proper test equipment for the system being tested.
 - 2. Re-terminate and re-test any cables or pairs of cables failing end-to-end testing requirements. Replace any faulty cables/pairs or termination devices. Remove all defective cables completely from pathways.
- B. As-Built
 - 1. Accurate as-built drawings shall be provided in electronic and hard copy format.
 - a. Drawings shall accurately show and describe all cable routing and equipment location in redline format.
 - b. 3 copies of electronic (CAD) drawings shall be distributed on appropriate media: 1 to construction management, 1 to designers and 1 to the school district.
 - c. 3 hard copies of CAD drawings shall be plotted on full size sheets and test results of every installed cable have been given to the construction management for appropriate distribution.

3.05 ACCEPTANCE

- A. The contractors’ work shall be considered complete after the following conditions have been met:
 - 1. Cable installation is complete, and all cable runs have been tested and documented to be installed according to specifications and drawings.
 - 2. A school district Technology representative has successfully tested the “LIVE” system.
 - 3. All punch list items have been reconciled.

4. All disturbed ceiling panels, firestopping materials, covers, etc. have been properly reinstalled.
5. All materials and trash have been removed from the site.
6. A 2-Year Installers warranty has been given to the owner.
7. A 15-year channel warranty has been given to the owner.
8. Submit Manufacturers Extended Warranty Application.

END OF SECTION

**SECTION 272000
NETWORK EQUIPMENT**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. LAN Electronics (Owner Furnished, Contractor Installed)
- B. Wireless Electronics (Owner Furnished, Contractor Installed)
- C. Power Protection Equipment (CFCI)

1.02 DEFINITIONS

- A. “Backbone Cabling” refers to telecommunications cabling that provides interconnections between telecommunications rooms, equipment rooms, and entrance facilities.
- B. “Communications Network Outlet (CNO)” refers to a collection of one or more mechanical cable termination device for horizontal cable in the work area.
- C. “Horizontal Cabling” refers to the cabling between and including the work area communications network outlet and the horizontal cross-connect in the telecommunications room.
- D. “Telecom Room (TR)” refers to an enclosed space for housing telecommunications equipment, cable terminations, and cross-connects. The room is the recognized cross-connect between the backbone or trunk cabling and horizontal cabling.
- E. “Telecom Equipment Room (TER)” refers to a centralized space for telecommunications equipment that serves the occupants of the building, usually containing the headend equipment for the distribution systems found in the building.

1.03 SYSTEM DESCRIPTION

- A. Design Requirements
 - 1. Provide labor, materials, equipment, services and operations required for complete installation of LAN compatible with Ethernet 10Base-T (10Mbps), Fast Ethernet 100Base-T (100Mbps), 155Mbps ATM and Gigabit Ethernet 1000 Base-T (1000Mbps) with single mode fiber optic backbone cable and Category 6/6a copper horizontal (station) wiring.
 - 2. Chassis Switch in TER shall be connected to access switches located in Telecommunication Rooms (TR/IDF) by the fiber backbone. Access switches shall distribute data throughout the network over twisted-pair cable.
 - 3. Network devices must be able to accommodate 100% of network outlets, with at least 15% spare ports in aggregate for future use.
 - 4. Network equipment shall be capable of supporting multiple Virtual Local Area Networks (VLAN), VoIP protocols, ATM protocols and Gigabit Ethernet.
 - 5. Permanently identify and label all cables and termination devices, at distribution rack and workstation in accordance with ANSI TIA-606-A Standard or as agreed by Design consultant and Authority.

B. Performance Requirements

1. Comply with applicable requirements in Local, State and Federal Codes, ANSI/TIA Standards, and BICSI methodology. Industry Codes, Standards and Methods shall be observed, including the following:
2. ANSI/TIA-568.0-E: Generic Telecommunications Cabling for Customer Premises
3. ANSI/TIA-568.1-E: Commercial Building Telecommunications Cabling Standard
4. ANSI/TIA-568.2-D: Balanced Twisted Pair Cabling and Components Standard
5. ANSI/TIA-568.3-D: Optical Fiber Cabling Components Standard
6. ANSI/TIA-569-E: Commercial Building Standard for Telecommunications Pathways and Spaces
7. ANSI/TIA-606-C: Administration Standard for Telecommunications Infrastructure of Commercial Buildings
8. ANSI/TIA-607-D: Commercial Building Grounding and Bonding Requirements for Telecommunications
9. ANSI/TIA-758-B: Customer-Owned Outside Plant Telecommunications Cabling Standard
10. BICSI Telecommunications Distribution Methods Manual (TDMM), Latest Edition
11. National Fire Protection Agency (NFPA-70): National Electrical Code (NEC)

1.04 SUBMITTALS

- A. Comply with the requirements of Division 1 - Submittals and as modified below.
- B. Product Data: Submit manufacturer's product literature, technical specifications and similar information for the following items demonstrating compliance with the specified requirements.
1. Network Switch Equipment
 2. Patch Cables/Jumpers
 3. UPS Equipment
 4. Wireless Access Controller
 5. Wireless Access Points
- C. Shop Drawings
1. The Contractor shall submit detailed line drawings of all systems showing major components of the systems. Submit wiring diagrams showing connections for all systems and equipment. Submittals will be rejected without detailed line drawings.
 2. The shop drawings shall be submitted in hardcopy and electronic format. Provide quantities called out in Division 1.
- D. Quality Control Submittal
1. Test Reports: Submit complete sample test data and reports.
 2. Certificates

- a. Manufacturer Certification: Submit certification from manufacturer of products to be installed under this contract certifying that Installer is authorized by manufacturer to install specified products.
- b. Installer Experience Listing: Submit list of at least 5 completed projects as specified below in “Quality Assurance – Qualifications – Installer.”

E. As-Built Drawings and Test Results

- 1. Comply with requirements of Division 1, including submission of operating and maintenance instructions as item in “Operation and Maintenance Data” manual described in that Section.
- 2. Provide test results for all communications circuits installed, including UTP channel performance and fiber optic backbone cabling and terminations.
- 3. Accurate as-built drawings shall be provided in electronic and hard copy format.
 - a. Drawings shall accurately show and describe all cable routing and equipment location in redline format.
 - i. Location of outlets and equipment on building floorplans
 - ii. Identification of labeling used for outlets and distribution racks.
 - iii. Cable routing and pathways for telephone and LAN cabling.
 - b. 3 copies of electronic (CAD) drawings shall be distributed on appropriate media: 1 to construction management, 1 to designers and 1 to district technology staff.
 - c. 3 hard copies of CAD drawings shall be plotted on full size sheets and test results of every installed cable have been given to the construction management for appropriate distribution.

1.05 QUALITY ASSURANCE

- A. All Work shall be installed in a first class, neat and workmanlike manner by skilled Technicians. The quality of the workmanship shall be subject to inspection and approval by authorized district personnel. Any work found to be of inferior quality and/or workmanship shall be replaced and/or reworked until the approval of district staff is obtained.
- B. Installer Qualifications: Certified by equipment manufacturer for installation of equipment. The instructor must be qualified at the appropriate level to validate equipment warranty.
- C. Conditions for Consideration of "Or Equal" Products: Where products are specified by name and accompanied by the term "or equal", the proposed "or equal" product will be considered when the following conditions are satisfied. If all the following conditions are not satisfied, the Design Consultant will return requests without action, except to record noncompliance with these requirements:
 - 1. The proposed product does not require extensive revisions to the Contract Documents.

2. With the exception of the product name or number and manufacturer's name, proposed product conforms with requirements indicated on the Drawings and in the Specifications in every respect and will produce indicated results.
3. The proposed product is fully documented and properly submitted.
4. The proposed product has received necessary approvals of authorities having jurisdiction.
5. The proposed product is compatible with AND has been coordinated with other portions of the Work.
6. Proposed product provides the specified warranty.
7. If the proposed product involves more than one contractor, the proposed product has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
8. The submission is accompanied with detailed comparison of significant qualities of the proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
9. The submission is accompanied with a list of similar installations for completed projects with project names and addresses and names and addresses of design consultants and authorities, if requested.
10. The submission is accompanied with the proposed product's Manufacturer signed written statement on Manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents.

1.06 WARRANTY

1. All manufacturer warranties shall be activated and passed on to the Owner. The warranty shall commence from the time of substantial completion for a period of two years.

1.07 OPERATION AND MAINTENANCE MANUALS

1. All applicable materials shall be given to the owner during training in electronic and hardcopy format if available.
2. Any password or key for specific systems shall be given to the owner as part of the operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

1. All networking switching electronics shall be based on Cisco Meraki or owner's preference at the time of construction.
2. Catalog and part numbers must be from the most current vendor catalogs available at the time of installation.

3. Wireless Equipment shall be from Cisco Meraki or owner's preference at the time of construction.

2.02 EQUIPMENT

- A. Access Layer Switches (Owner Furnished, Contractor Installed)
 1. Fast Ethernet POE Stackable Switches and components
 - a. Cisco Meraki MS225-24P-HW
 - b. Cisco Meraki LIC-MS225-24P-10YR
 - c. Cisco Meraki MS225-48FP-HW
 - d. Cisco Meraki LIC MS225-48FP-10YR
 - e. Cisco Meraki MA-CBL-40G-50CM
 - f. Cisco Meraki MA-CBL-40G-1M
 - g. Cisco Meraki MA-CBL-40G-3M
 - h. Cisco Meraki MA-CBL-TA-3M
 - i. Cisco Meraki SFP-10G-LRM
 - j. Cisco Meraki MA-SFP-10GB-LRM
 - k. Cisco Meraki Single Mode LC-LC 3 Meter
 - l. Provide all with power supplies.
 - m. Provide all with stacking cables.
 - n. Provide all with 10 Gig Transceivers.
 2. Maintenance and Warranty
 - a. Per device
- B. Power Protection Equipment (Contractor Furnished, Contractor Installed)
 1. Preferred Alternate
 - a. APC
 2. Acceptable Substitutes
 - a. Tripplite
 - b. Eaton
 3. UPS Equipment -with wall mount
 - a. APC SMTL3KRM2UCLNC with PDU (Lithium Batteries)
 - i. Eaton PDUMVR30NETLX

2.03 WIRELESS EQUIPMENT

- A. The exact quantity of wireless access points shall be determined by the wireless site survey at the time of installation.
- B. The wireless controller shall be sized appropriately based on the exact number of installed wireless access points.
- C. Wireless Controller (Owner Furnished, Contractor Installed)
 - 1. Meraki Cloud Management
- D. Wireless Access Point (Owner Furnished, Contractor Installed)
 - 1. Meraki MR44
 - a. With Access Point License.
 - b. With Grid Mount Kit
 - c. With Wall Mount Kit
 - 2. Meraki MR56 (Large Spaces, Gyms, Cafés, Auditoriums)
 - a. With Access Point License.
 - b. With Grid Mount Kit
 - c. With Wall Mount Kit

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine conditions under which telecommunications cabling and equipment and related components are to be installed in coordination with Installer of materials and components specified in this Section and notify affected Prime Contractors and design consultants in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected to ensure a safe and timely installation.
 - 1. When the installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Design consultant written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.
 - 2. Visit Site to identify and become familiar with existing field conditions and specific requirements of each Site.
 - 3. Verify all dimensions in the field and confirm the condition of existing hardware to be utilized.
 - 4. Confirm space requirements and physical confines of all work areas to ensure that all materials can be installed in indicated spaces.

5. Confirm all outlet locations and cable pathways and advise the design consultant in writing of any discrepancies or issues in design described in Contract Documents.

3.02 INSTALLATION

A. Power Protection Equipment

1. UPS shall be mounted in equipment racks according to manufacturer's specifications and as shown on T-series drawings.
2. Coordinate the location of twist-lock electrical power with UPS equipment in all telecom rooms.
3. All network equipment in telecom rooms shall utilize UPS power, except as noted in T-series drawings or individual spec sections.
4. Provide sufficient battery capacity for equipment in individual telecom rooms.

B. Switching Electronics

1. The contractor shall securely mount switches in distribution racks as shown on T-series drawings.
2. Equipment shall utilize UPS power, through multi-outlet power strips.
3. The contractor shall verify and provide test results showing 100% functionality of switch ports.
4. Switches shall be interconnected using manufacturer recommended patch cords, transceivers and equipment cords.
5. Wireless Equipment
 - a. Contractor shall perform a wireless site survey to provide complete building coverage at a minimum of 1 Gb/sec in all locations.
 - b. Utilize W type drops located above the ceiling grid throughout the facility.
 - c. The wireless system shall be completely operational and programmed through wireless controllers located in equipment racks.
6. Network Architecture
 - a. The contractor shall maximize singlemode cabling between head end and telecom rooms, so that most switches are directly fed into core switch. When stacking is required due to limited availability of fiber, contractors shall verify in writing to Architect.
 - b. All PoE switches shall be connected through singlemode fiber optic cabling directly to core switch.
 - c. The contractor shall verify configuration of switches with School District personnel and reserve up to 16 hours to coordinate installation with School District employees.

C. Network Server

1. Server shall be installed per manufacturer's specifications in the distribution rack in Equipment Room.
2. Coordinate installation and configuration of server directly with School District employees.
3. Provide all patch and equipment cords necessary for full installation.

3.03 LABELING

- A. Permanently identify all system components following ANSI/TIA-606A "Administration Standard for Commercial Telecommunications Infrastructure" with identification format:
 1. Each individual patch cord shall be labeled on both ends regardless of cable intended use. Labels must be machine printed with permanent black ink on laminated white label material. Contractors must check with appropriate district personnel for an appropriate labeling scheme. The intended format and labeling material must be approved by the district Technology Department before labeling begins.
 2. Equipment shall be given a unique identifier, corresponding to as-built drawings.
 3. Refer to T-Drawings for naming conventions.

3.04 TESTING

- A. Upon completion of work, all parts of the telecommunications installation shall be tested by the Telecommunications Contractor and demonstrated free of any defects. Preliminary testing will be permitted but shall not be accepted in lieu of obtaining final test results. Final test results shall be accomplished by the use of proper test equipment for the system being tested.

3.05 ACCEPTANCE

- A. The contractors' work shall be considered complete after the following conditions have been met:
 1. Network, Wireless and VoIP Equipment has been provided, installed and tested for functionality.
 2. Switching equipment has been demonstrated to allow a "ping" from any point on the LAN to equipment outside of LAN. The contractor shall coordinate with the School District to schedule a demonstration of network equipment.
 3. Patch cords have been properly installed. Any patch cords not employed in the network shall be assembled and turned over to the school district.
 4. All punch list items have been reconciled.
 5. All disturbed ceiling panels, firestopping materials, covers, etc. have been properly reinstalled.
 6. A two-year warranty has been provided to the owner.
 7. All materials and trash have been removed from the site.

8. Manufacturers' Warranty Certificates and product materials have been given to the Owner.

END OF SECTION

SECTION 28 05 01
SECURITY PATHWAYS AND SPACES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Telecommunications Room Build Out
- B. Pathways for Security Systems
- C. Grounding and Bonding for Security

1.02 References

- A. Industry Codes, Standards and Methods shall be observed, including the following:
 - 1. ANSI/TIA-568-C.0: Generic Telecommunications Cabling for Customer Premises.
 - 2. ANSI/TIA-568-C.1: Commercial Building Telecommunications Cabling Standard
 - 3. ANSI/TIA-568-C.2: Balanced Twisted Pair Cabling and Components Standard
 - 4. ANSI/TIA-568-C.3: Optical Fiber Cabling Components Standard
 - 5. ANSI/TIA-569-B: Commercial Building Standard for Telecommunications Pathways and Spaces
 - 6. ANSI/TIA-570-B: Residential Telecommunications Cabling Standard
 - 7. ANSI/TIA-606-A: Administration Standard for Telecommunications Infrastructure of Commercial Buildings
 - 8. ANSI-J-STD-607-A: Commercial Building Grounding and Bonding Requirements for Telecommunications
 - 9. ANSI/TIA-758-D: Customer-Owned Outside Plant Telecommunications Cabling Standard
 - 10. BICSI Telecommunications Distribution Methods Manual (TDMM), Latest Edition
 - 11. National Fire Protection Agency (NFPA-70): National Electrical Code (NEC)
- B. Comply with all local, state and federal codes for telecommunications installations.

1.03 System Description

- A. Design Requirements
 - 1. The contractor shall outfit all telecom rooms according to TY Drawings. Pathways, wallboards and grounding equipment shall be installed according to the manufacturer's guidelines and industry standards.
 - 2. TR and TER layouts shall be approved by Technology personnel prior to installation.
- B. Performance Requirements

1. Materials and equipment will be installed in an orderly and precise manner. Clearances between equipment will prevent incidental damage or unsafe conditions.
2. Equipment shall provide proper support and housing of all intended active and non-active components.
3. Refer to Telecom Room Details for precise location of equipment and termination fields.

1.04 Submittals

A. Product Data

1. Provide product data for all equipment listed in Part 2
2. Equipment data must be submitted in a single package and clearly indicated for efficient review. (by specifications section) Equipment submittals not clearly called out will be rejected without question at the contractor's expense for resubmittal.
3. Product data must be approved by designer and owner prior to purchase and installation of equipment.
4. LEED Submittals
 - a. Product data for Credit IEQ 4.1: For adhesives and sealants applied within the building waterproofing envelope, documentation including printed statement of VOC content in g/L.
 - b. Product data for Credit IEQ 4.2: For paints and coatings applied within the building water proofing envelope, documentation including printed statement of VOC content in g/L.
 - c. Product data for Credit IEQ 4.4: For composite wood installed in the building interior as equipment backer boards, documentation indicating no added urea formaldehyde resins.

B. Shop Drawings

1. Provide scaled drawings to show proposed equipment locations and clearances of Telecom Rooms and equipment.
2. Shop drawings must be approved by the designer and owner prior to purchase and installation of any equipment.

C. As-Built Drawings

1. The contractor shall upon completion of the project provide a complete set of As-Built drawings. These drawings shall identify room numbers and outlet identification numbers for all low voltage cabling systems. Drawings should also include all IDF and MDF locations with a detailed layout of all racks, patch panels, trays, and wall fields.
2. Additional project information shall include Reline Details of all horizontal and backbone cable routes and pathways.

3. As-builts shall be submitted in electronic CAD format and in hardcopy at the end of the project.

1.05 Quality Assurance

A. Regulatory Requirements

1. All equipment shall be installed in a neat and professional manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the school district. Equipment and materials shall be of the quality and manufacturer indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Substitutions

1. Conditions for consideration of “Or Equal” Products: Where products are specified by name and accompanied by the term “or equal”, the proposed “or equal” product will be considered when the following conditions are satisfied.
 - a. If all the following conditions are not satisfied, Design Consultant will return requests without action, except to record noncompliance with these requirements.
 - b. Proposed product does not require extensive revisions to the Contract Documents.
 - c. With the exception of the product name or number and manufacturer’s name, proposed product conforms with requirements indicated on the Drawings and in the Specifications in every respect and will produce indicated results.
 - d. The proposed product is fully documented and properly submitted.
 - e. Proposed product is compatible with and has been coordinated with other portions of the Work.
 - f. Proposed product provides specified warranty.
2. If proposed product involves more than one contractor, proposed product has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
3. The submission is accompanied with detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
4. The submission is accompanied with a list of similar installations for completed projects with project names and addresses and names and addresses of design consultants and authorities, if requested.

1.06 Warranty

- A. Warranty: Installer must provide manufacturer’s warranty without cost to the owner during that time period, including materials, hourly costs, etc.,

- B. The installer's warranty shall guarantee workmanship for a period of two years, during which time any deficiency in installation shall be repaired or replaced at no additional cost to the school district. Contractor must respond within 2 business days of written notification.

PART 2 - PRODUCTS

2.01 Materials

- A. Adhesives, sealants, paints and coatings applied within the building waterproofing envelope: Comply with low-emitting requirements in Division 01 Section "Indoor Air Quality Requirements."
- B. Composite wood installed in the building interior as equipment backer boards: Contain no added urea formaldehyde resins.
- C. J-Hooks
1. J-Hooks shall be rated for low voltage cables.
 2. J-hooks shall be provided where cable tray and conduit are not present.
 3. J-hooks shall be installed on 5'-6' centers, not further apart.
- D. Conduit
1. In-wall conduit shall be provided for work in new areas. Refer to TY Drawings for conduit details.
 2. Conduit bend radii shall follow current ANSI/TIA standards for telecommunications.
 3. Refer to TY drawings for locations and sizes of all sleeves for telecommunications.
- E. Gang Boxes
1. In-wall Gang Boxes for low voltage
 - a. In-wall Double Gang Box for low voltage: 4 Inch Back Knockout, 4 Inch Side Knockout, 4 Inch End Knockout, Length 3 3/4 Inches, Width 3 25/32 Inches, Depth 3 1/2 Inches or comparable.
 2. Extra Deep in-wall gang boxes
 - a. 3 3/4" Deep, 2 3/16" Wide, 3 7/8" High
 - b. 4 Knockouts, 2 Per End
- F. Distribution Backboard
1. Plywood
 - a. 3/4" AC-grade plywood shall be provided as shown on T drawing details to line the walls within the TR. The plywood should be provided in 4' x 8' sheets.
 - b. Plywood shall be void free and painted on all sides with two coats of fire-resistant paint.

- G. Electrical Protection for Security Systems
 - 1. Telecommunications Primary Bonding Busbar (PBB) and Telecommunications Secondary Bonding Busbar (SBB)
 - a. The telecom grounding and bonding system shall be bonded to the main electrical ground for the facility and include the security systems.

PART 3 - EXECUTION

3.01 Examination

- A. Site Verification of Conditions
 - 1. Contractor shall ensure that sufficient space has been allocated for the installation of all equipment per TY Drawings prior to Installation. Clearances and existing equipment should be taken into consideration. If insufficient space exists, the Design consultant should be notified in writing, before proceeding with Installation.

3.02 Installation

- A. Distribution Backboard
 - 1. Securely fasten backboard to wall-framing members to ensure it can support attached equipment.
 - 2. Mount plywood on all available areas where telecommunications equipment may be located.
 - 3. Refer to TY Drawings for minimum coverage.
- B. Firestop
 - 1. Provide re-enterable, non-hardening, intumescent putty, rated for floors or wall, UL approved assembly, with approved packing material for fire stopping inside building cable penetrations through conduits sleeves.
 - 2. The material used for sealing all openings shall have a fire rating equal to or greater than the floor ceiling, wall or partition material.
- C. Sleeves and openings
 - 1. The security contractor shall provide sleeves through all walls and floors to protect cabling and or raceways installed as part of the telecommunications system. All sleeves shall extend through the respective wall or partition and finish with a connector protective bushing.
 - 2. Sleeves through all fire rated structures shall have the appropriate fire stop system.

END OF SECTION

SECTION 28 10 00
INTRUSION DETECTION SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Intrusion Detection cabling
- B. Intrusion Detection sensors
- C. Intrusion Detection end devices
- D. Intrusion Detection headend equipment
- E. Associated power supplies, terminations, equipment, labeling and associated cable performance testing.

1.02 Definitions

- A. Intrusion Detection system refers to burglar alarm equipment including motion detectors, door contacts, control panels, communication panels, power supplies, expansion modules and associated wiring.

1.03 System Description

- A. Design Requirements
 - 1. Remote Access: The system shall provide a method for users to remotely access the system and perform all of the functions possible on an operator terminal by LAN (IP). Provide network interface module and Cat 6 cable and associated connections to school's data network.
 - 2. Primary Control Unit: Control unit shall consist of a power supply, signal processing circuitry, tamper circuits, alarm relay and driver circuits. Solid state, modular construction of the control unit must be incorporated for quick and easy servicing.
 - 3. The system shall be installed so that 10 percent future area protection of each zone may be added without compromising system performance in any way and no additional control equipment is necessary.
 - 4. The system shall be continuously supervised by a tamper circuit to prevent defeat by cutting, jumping or shorting to ground one or more transducer lines. When the system is in the armed mode of operation or in the stand-by mode of operation, attempts at tampering will activate a remote trouble unit.
 - 5. All zone controls shall be tamperproof installations so that tampering with a zone control will activate the remote trouble module.
 - 6. The system shall operate from 120 volts, 60 Hz power under normal conditions. In the event of a power interruption, the system will automatically operate from a self-contained emergency D.C. power source located within the control cabinet. When normal A.C. power is restored, the system shall resume normal operation. Under no circumstance will interruption of A.C. power cause the system to generate false alarms or fail to operate.

7. Arming and disarming shall be controlled by keypads.
8. The system shall include the LCD readout style annunciator sensor zone and every hardwired door zone as indicated on the drawings.
9. A system operating keypad shall be a part of the annunciator. The keypad shall override the main arm/disarm clock.
10. System shall have ENTRY AND EXIT time of 60 seconds, and keypads shall sound audible tone during ENTRY AND EXIT.
11. Standby batteries. Quantity as required to support system for specified hours upon loss of power. Note: Security system shall be fed from school's emergency generator power source. It is the responsibility of the contractor to coordinate with other trades to fulfill this requirement regardless if shown on the contract drawings.
12. The control panel shall have provision to send a signal to the building's PA system when armed. The control panel shall have provision to send a different signal to the PA system when in alarm.
13. When the security alarm system is first armed, a voice warning shall announce, via interior public address speakers, that the alarm system has been armed and continually announce the time the occupants have to leave the building or disarm the system (a maximum of five [5] minutes). If alarm system is disarmed, voice warning shall shut down immediately.
14. All security alarm outputs shall generate a two-minute voice alarm, warning intruder(s) that the police have been notified, using interior public address speakers.
15. All devices shall be individually addressable.
16. DS2e Stoppers (wire guards): Safety Technology International, STI series. Provide for all devices in gym, locker rooms, and other high abuse areas noted on drawings.
17. Interface security system to external digital communicator/dialer, refer to drawing(s) for additional requirements.
18. Panel shall be capable of arming and disarming by a maintained relay contact.
19. Provide labor, materials, equipment, services and operations required for a complete installation of an Intrusion Detection System.
 - a. Base panel
 - b. Expansion modules
 - c. Keypads
 - d. Annunciators
 - e. Motion Detectors
 - f. Door Contacts
 - g. Communication Modules

- h. Power Supplies
- i. Controllers
- j. Servers
- k. Application Software

20. All wiring shall be wired according to manufactures specifications.

- a. Refer to notes on each drawing to determine exact installation methods.
- b. Strictly adhere to most current version of ANSI/TIA Telecommunications cabling standards.
- c. Permanently identify and label all cables and termination devices, at distribution rack and workstation in accordance with ANSI TIA-606 Standard or as agreed by Design consultant and Authority.
- d. Remove and replace any cables failing to meet end-to-end testing requirements; do not abandon cable in place. All cable shall be terminated at both ends, unless noted in TY-Drawings.

B. Performance Requirements

- 1. The system shall be capable of interface with the Building Control System at the facility.
- 2. The system shall be capable of interface to the lighting control system at the facility
- 3. The system shall produce a signal if the system is breached by an unauthorized user.
- 4. Each sensor shall be individually alarmed.
- 5. The system shall be capable of a minimum of 8 partitions.
- 6. The system shall be capable of being scheduled.
- 7. The system shall be capable of being controlled from the main panel, keypad locations, central station and PC connected to the LAN.
- 8. The intrusion detection system will alert and record movement throughout the facility that is both authorized and unauthorized.
- 9. The systems will be capable of communicating onsite as well as to remote locations.
- 10. The systems shall be controllable in case of emergency situation.
- 11. All systems shall operate on dedicated circuits with associated cabling in EMT.
- 12. Comply with applicable requirements in Local, State and Federal Codes, ANSI/TIA Standards, and BICSI methodology.
- 13. Specified cabling system derived from recommendations in approved telecommunications industry codes, standards and methods, including the following documents:

- a. Articles 250, 725, 760, 770, 800,810 and 820 of the current National Electrical Code.
- b. ANSI/TIA-568-B.1: Commercial Building Telecommunications Cabling Standard Part 1 – General Requirements
- c. ANSI/TIA-568-B.2: Commercial Building Telecommunications Cabling Standard Part 2 – Balanced Twisted Pair Cabling Components and subsections.
- d. ANSI/TIA-568-B.3: Commercial Building Telecommunications Cabling Standard Part 3 – Optical Fiber Cabling Components
- e. ANSI/TIA-569-A: Commercial Building Standard for Telecommunications Pathways and Spaces
- f. ANSI/TIA-606: Administration Standard for Telecommunications Infrastructure of Commercial Buildings
- g. ANSI/TIA-607-D: Commercial Building Grounding and Bonding Requirements for Telecommunications
- h. BICSI Telecommunications Distribution Methods Manual (TDMM), Latest Edition
- i. National Fire Protection Agency (NFPA-70): National Electrical Code (NEC)

1.04 Submittals

- A. Comply with requirements of Division 0 and Division 1 - Submittals and as modified below.
- B. Product Data: Submit manufacturer's product literature, technical specifications and similar information for the following items demonstrating compliance with the specified requirements.
 1. Motion Detectors, Door Contacts, Keypads
 2. Headend Control Panels and Communications Modules
 3. Power supplies
 4. Copper cable and termination devices.
 5. Inner duct and accessories.
 6. Wiring diagrams.
 7. Controllers
 8. Servers
- C. Shop Drawings: Provide complete shop drawings showing all devices, device connections, wiring pathways, wire types, headend equipment elevations and associated components prior to installation, for approval by designer.

- D. Samples: Provide samples of assemblies and connections as described below, prior to installation, for approval by designer.
 - 1. Intrusion Detection cables and connections – Submit samples of cables and terminations to be provided including following components and characteristics:
 - a. Provide all components in colors selected by Design consultant.
- E. Quality Control Submittal
 - 1. Test Reports: Submit complete sample test data and reports with exact labels used on cables termination fields.
 - 2. Certificates
 - a. Manufacturer Certification: Submit certification from manufacturer of products to be installed under this contract certifying that Installer is authorized by manufacturer to install specified products.
 - b. Installer Experience Listing: Submit list of at least 5 completed projects as specified below in “Quality Assurance – Qualifications – Installer.”
- F. Contract Closeout Submittal: Comply with requirements of Division 0, including submission of operating and maintenance instructions as item in “Operation and Maintenance Data” manual described in that Section.

1.05 Quality Assurance

- A. All Work shall be installed in a first class, neat and workmanlike manner by skilled Technicians. The quality of the workmanship shall be subject to inspection and approval by authorized school district personnel. Any work found to be of inferior quality and/or workmanship shall be replaced and/or reworked until the approval of school district personnel is obtained.
- B. Qualifications
 - 1. Installer
 - a. Qualified to cable, terminate, program and test Intrusion Detection systems, and associated power wiring specified in this Section and other Division 17000 series specifications, certified by manufacturer of products to be installed, and completed at least 5 installations of similar size, nature and complexity as specified for this project.
- C. Conditions for Consideration of "Or Equal" Products: Where products are specified by name and accompanied by the term "or equal", the proposed "or equal" product will be considered when the following conditions are satisfied. If all the following conditions are not satisfied, Design Consultant will return requests without action, except to record noncompliance with these requirements:
 - 1. Proposed product does not require extensive revisions to the Contract Documents.
 - 2. With the exception of the product name or number and manufacturer's name, proposed product conforms with requirements indicated on the Drawings and in the Specifications in every respect and will produce indicated results.

3. Proposed product is fully documented and properly submitted.
4. Proposed product has received necessary approvals of authorities having jurisdiction.
5. Proposed product is compatible with AND has been coordinated with other portions of the Work.
6. Proposed product provides specified warranty.
7. If proposed product involves more than one contractor, proposed product has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
8. Submission is accompanied with detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
9. Submission is accompanied with a list of similar installations for completed projects with project names and addresses and names and addresses of design consultants and authorities, if requested.
10. Submission is accompanied with proposed product's Manufacturer signed written statement on Manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents.

1.06 Warranty

- A. Installer's Warranty: Provide manufacturer's system warranty against electrical or mechanical defects for 2 years from date of final acceptance.
- B. Manufacturer warranty coverage for cable systems associated with the Intrusion Detection System

1.07 Training

- A. Installing contractor shall provide a minimum of 8 hours of training on system operation and managements as part of their scope of work.
 1. Additional hours shall be provided on a time and materials basis at the request of the owner.
- B. Installing contractor shall provide a video recording on a standard format DVD to the owner which includes training sessions.

1.08 Operation And Maintenance Manuals

- A. Installing contractor shall provide a minimum of two hardcopy and one electronic copy of all operation and maintenance manuals to the owner at project completion.

PART 2 - PRODUCTS

2.01 Manufacturers

- A. Basis of Design – Must match the system in the main building

1. Honeywell

2.02 Intrusion Detection

A. Control Panel

1. Honeywell

- a. Up to 599 points
- b. Support for 32 Keypads
- c. Up to 8 partitions

2. Plug-in Phone Line

- a. Honeywell

3. Cellular Communicator

- a. Honeywell

4. Ethernet Module

- a. Honeywell

5. Keypads

- a. Honeywell with LCD Display

6. Motion Detectors

- a. Wide Angle
- b. Medium Range
- c. Long Range

7. Door Contacts (DPDT Type)

- a. ¾” Recessed
- b. Surface Mount
- c. Overhead Door

8. Expansion Modules

- a. Honeywell Expander

9. Wired Panic Button

- a. ISC-PB1-100
 - i. Provide and install 2 units in the main office
 - ii. Provide and install 1 unit in the principal office

10. Wireless Panic Button
 - a. Bosch Radion RFPB-TB-A
 - i. Provide 2 units
 11. Wireless Receiver and Repeater
 - a. Honeywell
 - i. Install no more than 800 ft. from the control panel.
 - ii. Exact location TBD in the field
 - b. Radion RFRP-A
 - i. Install 8 units around the building for coverage, locations to be determined in the field
 12. Power Supplies
 - a. Located in MDF and IDF Rooms as required.
 13. Cable
 - a. Two Conductor 18 AWG min
 - b. Four Conductor 18 AWG min
 14. Battery Backup
 - a. Provide properly sized backup battery power supply for full system operation.
- B. Cable/Wiring
1. ALL CABLE/WIRING SHALL BE RUN IN WHITE, EMT CONDUIT. Provide Allied True Color products, or equal. All junction boxes are to be painted white to match conduit. All wiring shall be concealed. No surface metal raceway shall be used unless approved by owner, and if approved, shall be painted to match adjacent wall color.
 - a. General: 18-AWG, 4-wire, unshielded.
 2. Surge Protection: Provide transient surge protection devices on the power feeds for all major components of equipment. This shall include equipment with electronic components such as the control panel. Surge protection devices shall be UL listed, equal to Transtector or Isobar. The devices shall have a 5 nanosecond or less response time for clipping excessive voltage. The surge protection devices shall consist of solid state circuitry, will automatically reset after an operation with no degradation in protective capability and have an indicated light to indicate when the unit is non-operational. Devices shall be direct plug-in type, plug strip type, or hard-wired connection type as applicable.

PART 3 - EXECUTION

3.01 Examination

- A. Verification of Conditions: Examine conditions under which Intrusion Detection cabling and equipment and related components are to be installed in coordination with Installer of materials and components specified in this Section and notify affected Prime Contractors and Design consultant in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected to ensure a safe and timely installation.
 - 1. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Design consultant written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.
 - 2. Visit Site to identify and become familiar with existing field conditions and specific requirements of each Site.
 - 3. Verify all dimensions in field and confirm condition of existing hardware to be utilized.
 - 4. Confirm space requirements and physical confines of all work areas to ensure that all materials can be installed in indicated spaces.
 - 5. Confirm all outlet locations and cable pathways and advise Design consultant in writing of any discrepancies or issues in Design described in Contract Documents.

3.02 Preparation

- A. Protection: Provide adequate protection of equipment and hardware before and after installation.
- B. Existing Intrusion Detection Equipment: Ensure all systems remain operational throughout the project.
 - 1. Identify any circuits and/or wiring at the site not shown on TY-Drawings and interfering with installation of specified Equipment.
 - 2. Remove all accessible portions of abandoned communications cabling per NEC 800.52. Tag all communications cabling not terminated at both ends but retained for future use.

3.03 Installation

- A. Provide and install all components necessary to install a complete Intrusion Detection System, including (but is not limited to) connectors, sensors, panels, power supplies, terminators, etc...
 - 1. Cable runs shall be per manufacturer's recommendations in all cases. Any deviation will result in system rejection.
 - 2. Secure all horizontal cables within ceiling cavities to building structure.
 - 3. Loosely bundle all cables and support from structure at unequal intervals from 5 to 6 feet with spring steel fasteners and cable clip rated for use with high performance

cables where cable tray or other support structure has not been provided as indicated on Drawings. All mounting clips shall be seismic type as per BOCA.

4. Do not violate manufacturer's recommended loadings. Leave 30% capacity for future use of pathway.
 5. Do not support cables from ceiling grid T-Bars, grid wire supports or bridle rings. Do not allow cables to touch ceiling grid.
 6. Install cables in EMT conduit in all unfinished, exposed areas as shown in Design consultant and Architectural roof plans and/or TY-Drawings, unless alternate pathways are noted.
 7. Do not secure cables with permanent cable ties. Do not tighten cable bundles in such a way as to cause jacket deformation
 8. Place cables in compliance with ANSI/TIA-568.B standards and BICSI recommended methods.
 9. Tight 90-degree bends are unacceptable, and use of plastic "cinch-type" tie-wraps are not permitted, in order to prevent damage to cable jacket and compromise the cable's electrical or optical characteristics.
 10. Cable bundles shall be neatly routed with a service loop to provide 10 feet of slack at the cross-connect end and as noted in the T-drawings. Cable bundles shall be secured using only black Velcro cable wraps.
- B. Install all exposed cabling in surface raceway by Wiremold, Hubbell or Panduit where in-wall conduit has not been provided. Follow all manufacturers' guidelines requirements regarding bending radius and slack. All bends, offsets and fittings shall be appropriately sized to provide 30% capacity after installation.
- C. Install all cables in accordance with National, state and local codes and ANSI/TIA Standards, and BICSI methods.
1. Follow manufacturer's guidelines and requirements for all cable termination.
 2. Identification: Provide permanent identification labels for patch panels, access panels and entrance facilities.

3.04 Testing

A. Intrusion Detection System

1. Upon completion of work, all parts of the systems installation shall be tested by the installing Contractor and demonstrated free of any defects. Preliminary testing will be permitted but shall not be accepted in lieu of obtaining final test results. Final test results shall be accomplished by the use of proper test equipment for the system being tested.
2. Each device shall be demonstrated to individually alarm and pinpoint the exact triggered sensor. Any system failing this requirement will be wholly rejected at the contractor's expense.

3. Re-terminate and re-test any cables or pairs of cables failing end-to-end testing requirements. Replace any faulty cables/pairs or termination devices. Remove all defective cables completely from pathways.

3.05 As-Builts

- A. All devices shall be shown in their accurate location
- B. All equipment and cables shall be properly identified and labeled.
- C. Accurate as-built drawings shall be provided in electronic and hard copy format.
 1. 3 copies of electronic (CAD) drawings shall be distributed on appropriate media: 1 to construction management, 1 to designers and 1 to school district personnel.
 2. 3 hard copies of CAD drawings shall be plotted on full size sheets and test results of every installed cable have been given to the construction management for appropriate distribution.

3.06 Demonstration

- A. Intrusion Systems Demonstration
 1. 16 Hours of demonstration and training on all aspects of the completely installed systems must be provided for the owner.
 - a. Training shall be video recorded for the owner and given to them after acceptance.
 - b. Training and system demonstration must include all aspects of the system and its operation.
 - c. Additional training, beyond the initial 16 hours, shall be provided for the owner at their request on an hourly rate basis.

3.07 Acceptance

- A. The contractors work shall be considered complete after the following conditions have been met:
 1. Cable and equipment installation is complete and all cables and equipment have been tested and documented to be installed according to specifications and drawings. Use form at the bottom of this specification for zone descriptions and delineation.
 2. A school district Security representative has successfully tested the “LIVE” system.
 3. All punch list items have been reconciled.
 4. All disturbed ceiling panels, covers, etc. have been properly reinstalled.
 5. All materials and trash have been removed from the site.
 6. A 2-Year Installers warranty has been given to a school district Security representative.
 7. Submit Manufacturers Extended Warranty Application.

PAUL M. HODGSON VOCATIONAL
TECHNICAL HIGH SCHOOL

Subscriber Name _____

☐ ADDENDUM TO A NEW SUBSCRIBER MONITORING AGREEMENT.
☐ CHANGE TO DATA ON AN EXISTING SUBSCRIBER ACCOUNT.

FOR YOUR CONVENIENCE, PANEL PRINT OLITS ARE ACCEPTED. HOWEVER, PLEASE INDICATE CALLBACK OPTION. EXCLUSION OF THIS INFORMATION MAY DELAY THE PROCESSING OF A SUBSCRIBER MONITORING AGREEMENT. IF YOU HAVE ANY QUESTIONS, PLEASE CONTACT YOUR SALES REPRESENTATIVE.

PARTITIONED: ☐ NO ☐ YES (DEFINE BELOW)

1	5
2	6
3	7
4	8

[illegible]

Bid Pack E – Fieldhouse, Athletic Fields and Storage Buildings

SECTION 28 11 00
ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Access Control cabling
- B. Access Control sensors
- C. Access Control devices
- D. Access Control headend equipment
- E. Access Control Hardware, Panels, Nodes, Card Readers, Servers, Software and associated cabling.
- F. Associated power supplies, terminations, equipment, labeling and associated cable performance testing.
- G. Wireless Locks

1.02 Definitions

- A. Access Control system refers to system database to allow or prevent access to the facility.
- B. Access Control system refers equipment including card readers, door controllers, access control panels, access control cards, access control database, door contacts, control panels, communication panels, power supplies, expansion modules and associated wiring.

1.03 System Description

- A. Design Requirements
 - 1. Provide labor, materials, equipment, services and operations required for complete installation of an integrated Access Control System with the electric door hardware, intrusion detection system and CCTV system.
 - 2. Remote Access
 - a. The system shall provide a method for users to remotely access the system and perform all of the functions possible on an operator terminal by LAN (IP). Provide Cat 6 cable and associated connections to school's data network. Install associated system software on all administrative and custodial office computers (pc's) for controlling and monitoring system. Turn over software disc to owner after installations.
 - 3. Provide labor, materials, equipment, services and operations required for a complete installation of an Access Control System.
 - a. Base panel
 - b. Expansion modules
 - c. Card Readers

- d. Door Controllers
 - e. Communication Modules
 - f. Power Supplies
 - g. Controllers
 - h. Servers
 - i. Cabling and connectors
 - j. Application Software
4. All wiring shall be wired according to the manufacturer's specifications.
- a. Refer to notes on each drawing to determine exact installation methods.
 - b. Strictly adhere to most current version of ANSI/TIA Telecommunications cabling standards.
 - c. Permanently identify and label all cables and termination devices, at distribution rack and workstation in accordance with ANSI/TIA-606 Standard or as agreed by Design consultant and Authority.
 - d. Remove and replace any cables failing to meet end-to-end testing requirements; do not abandon cable in place. All cable shall be terminated at both ends, unless noted in TY-Drawings.
- B. Performance Requirements
- C. Access Control System Requirements
- 1. The system shall interface with the Building Controls System at the facility.
 - 2. The system shall allow or prevent access to the facility and certain areas of the facility.
 - 3. The system shall provide notification of events occurring on the system.
 - 4. The system shall be on emergency power systems.
 - 5. The system shall be on the local area network.
 - 6. The system shall be connected to the Intrusion Detection System.
 - 7. The system shall integrate with other currently installed systems within the district.
 - 8. The system shall allow for a key to override any lock.
 - 9. The system shall be field controllable and programmable.
 - 10. The system shall allow for instantaneous deletion of a card holder from the system.
 - 11. The system shall allow for access restriction.
 - 12. The system shall have a backup database.

13. The contractor shall be responsible for form, fit, function, and coordination of all part numbers listed above, and bring to owner's attention any changes or substitutions for approval.
14. Indoor/outdoor card readers shall be recessed. No exposed conduit shall be used.
15. No surface metal raceway shall be used unless approved by the owner, and if approved, shall be painted to match adjacent wall color.
16. The system shall be capable of being scheduled.
17. The systems will be capable of communicating onsite as well as to remote locations.
18. The systems shall be controllable in case of an emergency situation.
19. All systems shall operate on dedicated circuits with associated cabling in EMT.

D. Codes

1. Comply with applicable requirements in Local, State and Federal Codes, ANSI/TIA Standards, and BICSI methodology.
2. Specified cabling system derived from recommendations in approved telecommunications industry codes, standards and methods, including the following documents:
3. ANSI/TIA-568-C.0: Generic Telecommunications Cabling for Customer Premises.
4. ANSI/TIA-568-C.1: Commercial Building Telecommunications Cabling Standard
5. ANSI/TIA-568-C.2: Balanced Twisted Pair Cabling and Components Standard
6. ANSI/TIA-568-C.3: Optical Fiber Cabling Components Standard
7. ANSI/TIA-569-B: Commercial Building Standard for Telecommunications Pathways and Spaces
8. ANSI/TIA-570-B: Residential Telecommunications Cabling Standard
9. ANSI/TIA-606-A: Administration Standard for Telecommunications Infrastructure of Commercial Buildings
10. ANSI-J-STD-607-D: Commercial Building Grounding and Bonding Requirements for Telecommunications
11. ANSI/TIA-758-A: Customer-Owned Outside Plant Telecommunications Cabling Standard
12. BICSI Telecommunications Distribution Methods Manual (TDMM), Latest Edition

1.04 National Fire Protection Agency (NFPA-70): National Electrical Code (NEC) Submittals

- A. Comply with requirements of Division 0 and Division 1 - Submittals and as modified below.

- B. Product Data: Submit manufacturer's product literature, technical specifications and similar information for the following items demonstrating compliance with the specified requirements.
 - 1. Card Readers
 - 2. Network nodes
 - 3. Network Node cards
 - 4. Access Controllers
 - 5. Headend Control Panels and Communications Modules
 - 6. Power supplies
 - 7. Copper cable and termination devices.
 - 8. Inner duct and accessories.
 - 9. Wiring diagrams.
 - 10. Servers
- C. Shop Drawings: Provide complete shop drawings of the system including floor plan locations, door elevation details and wiring details.
 - 1. Access Control cables and devices – Submit samples of cables and terminations to be provided including following components and characteristics:
 - a. Provide all components in colors selected by Design consultant.
- D. Quality Control Submittal
 - 1. Test Reports: Submit complete sample test data and reports with exact labels used on cables termination fields.
 - 2. Certificates
 - a. Manufacturer Certification: Submit certification from manufacturer of products to be installed under this contract certifying that Installer is authorized by manufacturer to install specified products.
 - b. Installer Experience Listing: Submit list of at least 5 completed projects as specified below in "Quality Assurance – Qualifications – Installer."
- E. Contract Closeout Submittal: Comply with requirements of Division 0, including submission of operating and maintenance instructions as item in "Operation and Maintenance Data" manual described in that Section.

1.05 Quality Assurance

- A. All Work shall be installed in a first class, neat and workmanlike manner by skilled Technicians. The quality of the workmanship shall be subject to inspection and approval by authorized school district personnel. Any work found to be of inferior quality and/or

workmanship shall be replaced and/or reworked until the approval of school district personnel is obtained.

B. Qualifications

1. Installer

- a. Qualified to cable, terminate, program and test Intrusion Detection systems, and associated power wiring specified in this Section and other Division 17000 series specifications, certified by manufacturer of products to be installed, and completed at least 5 installations of similar size, nature and complexity as specified for this project.

C. Conditions for Consideration of "Or Equal" Products: Where products are specified by name and accompanied by the term "or equal", the proposed "or equal" product will be considered when the following conditions are satisfied. If all the following conditions are not satisfied, Design Consultant will return requests without action, except to record noncompliance with these requirements:

1. The proposed product does not require extensive revisions to the Contract Documents.
2. With the exception of the product name or number and manufacturer's name, proposed product conforms with requirements indicated on the Drawings and in the Specifications in every respect and will produce indicated results.
3. The proposed product is fully documented and properly submitted.
4. The proposed product has received necessary approvals of authorities having jurisdiction.
5. The proposed product is compatible with AND has been coordinated with other portions of the Work.
6. The proposed product provides the specified warranty.
7. If proposed product involves more than one contractor, proposed product has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
8. The submission is accompanied with detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
9. The submission is accompanied with a list of similar installations for completed projects with project names and addresses and names and addresses of design consultants and authorities, if requested.
10. The submission is accompanied with the proposed product's Manufacturer signed written statement on Manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents.

1.06 Warranty

- A. Installer's Warranty: Provide manufacturer's system warranty against electrical or mechanical defects for 2 years from date of final acceptance.
- B. A fifteen (15) year Extended Product Warranty and Systems Assurance Warranty for UTP camera wiring system shall be provided by the Manufacturer as follows:
 - 1. System Certification: Upon successful completion of the installation and subsequent inspection, the Authority shall be provided with a numbered certificate, from the manufacturing company, registering the installation.

1.07 Training

- A. The installing contractor shall provide a minimum of 8 hours of training on system operation and managements as part of their scope of work.
 - 1. Additional hours shall be provided on a time and materials basis at the request of the owner.
- B. The installing contractor shall provide a video recording on a standard format DVD to the owner which includes training sessions.

1.08 Operation And Maintenance Manuals

- A. The installing contractor shall provide a minimum of two hardcopy and one electronic copy of all operation and maintenance manuals to the owner at project completion.

PART 2 - PRODUCTS

2.01 Manufacturers

- A. Basis of Design – Must match system in the main building.
 - 1. Salto

2.02 Access Control Components (Must fully integrate with the electric hardware included in Division 08)

- A. Salto
 - 1. Client Software
 - a. Enterprise Edition
 - b. Wireless Reader License
 - 2. Controllors
 - a. Salto
 - i. Quantity as required to support card reader locations.
 - b. Salto
 - i. Quantity as required to support card reader locations.
 - 3. Dual Reader modules

- a. Salto
 - b. Quantity as required to support card reader locations.
4. Enclosures
 - a. Salto
 - b. Quantity as required to support card reader locations.
5. Power Supplies
 - a. Salto
6. Advanced Logic Relay
 - a. Camden CX-33 (include as needed for complex door integrations)
7. Additional Nodes
 - a. Supervised Input Blades
 - b. Relay Controlled Output Blades
 - c. I/O Module, for interface with school's security panel.
 - d. Access Power Controller, for interface with school's fire alarm panel.
 - e. Network Interface Module, for IP network link communications.
8. Card Readers
 - a. HID Signo Multi-Class reader 20/40
 - b. Salto
9. Access Card/FOB
 - a. Salto Mifare Classic 4K Cards
 - b. Quantity of five-hundred (500).
10. Power supply
 - a. Altronix eFlowSeries
 - b. Quantity as required to support system.
11. Standby batteries
 - a. Quantity as required to support system for specified hours upon loss of power.
Note: Card access system shall be fed from school's emergency generator power source. It is the responsibility of contractor to coordinate with other trades to fulfill this requirement regardless if shown on contract drawings (electrical drawings).
12. Door Contacts

- a. Sentrol DPDT Recessed
 - b. MC180 Door Channel Magnet
- 13. Request-to-exit Sensor
 - a. Honeywell IS310
 - b. with activation LED on doors where hardware does not provide egress.
- 14. Card Reader Pedestals
 - a. Pedestal Pro 42-3-12 with hood
 - b. Pedestal Pro 72-DSP-3-12-12 Dual with Hoods and Extensions
- B. Cabling
 - 1. Cat 6 UTP Data Cabling
 - 2. PW-Series daisy chain cable
 - 3. 18/2 AWG Plenum Cable
 - 4. 18/4 AWG Plenum Cable
 - 5. 18/6 AWG Plenum Cable
- C. Wireless Locks and Access Control
 - 1. Basis of Design: Salto Systems XS4 Original +ANSI
 - a. Always operable for egress
 - b. Virtual privacy option
 - c. Finish: US26D Satin Chrome, BioCote (antimicrobial)
 - 2. Provided as offline locks but with the ability to be reprogrammed as an online lock to communicate with the school security system.

PART 3 - EXECUTION

3.01 Examination

- A. Verification of Conditions: Examine conditions under which Intrusion Detection cabling and equipment and related components are to be installed in coordination with Installer of materials and components specified in this Section and notify affected Prime Contractors and Design consultant in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected to ensure a safe and timely installation.
 - 1. When the installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Design consultant written confirmation from applicable Installer.

Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

2. Visit Site to identify and become familiar with existing field conditions and specific requirements of each Site.
3. Verify all dimensions in field and confirm condition of existing hardware to be utilized.
4. Confirm space requirements and physical confines of all work areas to ensure that all materials can be installed in indicated spaces.
5. Confirm all outlet locations and cable pathways and advise Design consultant in writing of any discrepancies or issues in Design described in Contract Documents.

3.02 Preparation

- A. Protection: Provide adequate protection of equipment and hardware before and after installation.
- B. Existing Intrusion Detection Equipment: Ensure all systems remain operational throughout the project.
 1. Identify any circuits and/or wiring at the site not shown on TY-Drawings and interfering with installation of specified Equipment.
 2. Remove all accessible portions of abandoned communications cabling per NEC 800.52. Tag all communications cabling not terminated at both ends but retained for future use.

3.03 Installation

- A. Provide and install all components necessary to install a complete Intrusion Detection System, including (but is not limited to) connectors, sensors, panels, power supplies, terminators, etc...
 1. Cable runs shall be per manufacturer's recommendations in all cases. Any deviation will result in system rejection.
 2. Secure all horizontal cables within ceiling cavities to the building structure.
 3. Loosely bundle all cables and support from structure at unequal intervals from 5 to 6 feet with spring steel fasteners and cable clip rated for use with high performance cables where cable tray or other support structure has not been provided as indicated on Drawings. All mounting clips shall be seismic type as per BOCA.
 4. Do not violate manufacturer's recommended loadings. Leave 30% capacity for future use of pathway.
 5. Do not support cables from ceiling grid T-Bars, grid wire supports or bridle rings. Do not allow cables to touch the ceiling grid.
 6. Install cables in EMT conduit in all unfinished, exposed areas as shown in Design consultant and Architectural roof plans and/or T-Drawings, unless alternate pathways are noted.

7. Do not secure cables with permanent cable ties. Do not tighten cable bundles in such a way as to cause jacket deformation.
 8. Place cables in compliance with ANSI/TIA-568.B standards and BICSI recommended methods.
 9. Tight 90-degree bends are unacceptable and use of plastic “cinch-type” tie-wraps are not permitted, in order to prevent damage to cable jacket and compromise the cable’s electrical or optical characteristics.
 10. Cable bundles shall be neatly routed with a service loop to provide 10 feet of slack at the cross-connect end and as noted in the T-drawings. Cable bundles shall be secured using only black Velcro cable wraps.
- B. Install all exposed cabling in surface raceway by Wiremold, Hubbell or Panduit where in-wall conduit has not been provided. Follow all manufacturers’ guidelines requirements regarding bending radius and slack. All bends, offsets and fittings shall be appropriately sized to provide 30% capacity after installation.
- C. Install all cables in accordance with National, state and local codes and ANSI/TIA Standards, and BICSI methods.
1. Follow manufacturer’s guidelines and requirements for all cable termination.
 2. Identification: Provide permanent identification labels for patch panels, access panels and entrance facilities.

3.04 Testing

- A. Access Control System
1. Upon completion of work, all parts of the systems installation shall be tested by the installing Contractor and demonstrated free of any defects. Preliminary testing will be permitted but shall not be accepted in lieu of obtaining final test results. Final test results shall be accomplished by the use of proper test equipment for the system being tested.
 2. Each device shall be demonstrated individually and provide all functions as specified by the manufacturer’s literature. Any system failing this requirement will be wholly rejected at the contractor’s expense.
 3. Re-terminate and re-test any cables or pairs of cables failing end-to-end testing requirements. Replace any faulty cables/pairs or termination devices. Remove all defective cables completely from pathways.

3.05 As-Builts

- A. All devices shall be shown in their accurate location with associated wiring.
- B. All equipment and cables shall be properly identified and labeled.
- C. Accurate as-built drawings shall be provided in electronic and hard copy format.
1. 3 copies of electronic (CAD) drawings shall be distributed on appropriate media: 1 to construction management, 1 to designers and 1 to school district personnel.

2. 3 hard copies of CAD drawings shall be plotted on full size sheets and test results of every installed cable have been given to the construction management for appropriate distribution.

3.06 Demonstration

A. Access Control Systems Demonstration

1. 8 Hours of demonstration and training on all aspects of the completely installed systems must be provided for the owner.
 - a. Training shall be video recorded for the owner and given to them after acceptance.
 - b. Training and system demonstration must include all aspects of the system and its operation.
 - c. Additional training, beyond the initial 16 hours, shall be provided for the owner at their request on an hourly rate basis.

3.07 Acceptance

- #### A. The contractors work shall be considered complete after the following conditions have been met:
1. Cable and equipment installation is completed, and all cables and equipment have been tested and documented to be installed according to specifications and drawings.
 2. A school district Security and Technology representative has successfully tested the “LIVE” system.
 3. All programming has been provided and entered into the system.
 4. All punch list items have been reconciled.
 5. All disturbed ceiling panels, covers, etc. have been properly reinstalled.
 6. A 2-Year Installers warranty has been given to a school district Security representative.
 7. Submit Manufacturers Extended Warranty Application.

END OF SECTION

SECTION 28 20 00
VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Video Surveillance Cabling, Cameras, NVRs, VMS, Control Equipment, cabling and interface units.
- B. Halo Sensors, associated cabling and programming.
- C. Associated power supplies, terminations, labeling and associated cable performance testing.
- D. All materials, terminations, equipment, labeling and associated cable performance testing.

1.02 Definitions

- A. Refer to sections 27 and 28 for applicable definitions and terms.
- B. CCTV and video surveillance refer to the same system and are used interchangeably. Terms refer to the cabling system included in this specification section.

1.03 System Description

- A. Design Requirements
 - 1. Provide labor, materials, equipment, services and operations required for complete installation of a CCTV System.
 - a. Fiber/PoE extenders and associated power wiring shall be homerun from end device location to head equipment location without breaks or splices.
 - b. Cat 6 UTP network cables with all terminations from cameras to switches and control equipment shall be installed without splicing.
 - c. Cables shall be routed from distribution racks throughout the building as shown on T-Drawings.
 - i. Refer to notes on each drawing to determine exact installation methods.
 - ii. Note and record all cable lengths to the nearest foot.
 - iii. Strictly adhere to most current versions of ANSI/TIA Telecommunications cabling standards.
 - d. Permanently identify and label all cables and termination devices at distribution rack and workstation in accordance with ANSI/TIA-606 Standard or as agreed by Design consultant and Authority.
 - e. Remove and replace any cables failing to meet end-to-end testing requirements; do not abandon cables in place. All cables shall be terminated at both ends, unless noted in T-Drawings.

B. CCTV System Requirements

1. The system shall provide notification of events occurring on the system.
2. The system shall be on emergency power systems.
3. The system shall be on the local area network.
4. The system shall integrate with other currently installed systems within the district.
5. The system shall be field controllable and programmable.
6. The system shall allow for access restriction.
7. The contractor shall be responsible for form, fit, function, and coordination of all part numbers listed above, and bring to owner's attention any changes or substitutions for approval.
8. No surface metal raceway shall be used unless approved by the owner, and if approved, shall be painted to match adjacent wall color.

C. Performance Requirements

1. Comply with applicable requirements in Local, State and Federal Codes, ANSI/TIA Standards, and BICSI methodology.
2. Specified cabling system derived from recommendations in approved telecommunications industry codes, standards and methods, including the following documents:
 - a. ANSI/TIA-568-C.0: Generic Telecommunications Cabling for Customer Premises.
 - b. ANSI/TIA-568-C.1: Commercial Building Telecommunications Cabling Standard
 - c. ANSI/TIA-568-C.2: Balanced Twisted Pair Cabling and Components Standard
 - d. ANSI/TIA-568-C.3: Optical Fiber Cabling Components Standard
 - e. ANSI/TIA-569-B: Commercial Building Standard for Telecommunications Pathways and Spaces
 - f. ANSI/TIA-570-B: Residential Telecommunications Cabling Standard
 - g. ANSI/TIA-606-A: Administration Standard for Telecommunications Infrastructure of Commercial Buildings
 - h. ANSI-J-STD-607-D: Commercial Building Grounding and Bonding Requirements for Telecommunications
 - i. ANSI/TIA-758-A: Customer-Owned Outside Plant Telecommunications Cabling Standard
 - j. BICSI Telecommunications Distribution Methods Manual (TDMM), Latest Edition

k. National Fire Protection Agency (NFPA-70): National Electrical Code (NEC)

1.04 Submittals

- A. Comply with requirements of Division 0 and Division 1 - Submittals and as modified below.
- B. Product Data: Submit manufacturer's product literature, technical specifications and similar information for the following items demonstrating compliance with the specified requirements.
 - 1. Video Management System (VMS)
 - 2. Video Recorder Units (NVRs)
 - 3. Cameras.
 - 4. Fiber and PoE extenders.
 - 5. Copper cable, patch cables and termination devices.
 - 6. Video Surveillance Control Software.
 - 7. Video Surveillance Control Servers.
 - 8. Inner duct and accessories.
 - 9. Complete Wiring diagrams including floor plans and elevation diagrams.
 - 10. Sample of each cable test report.
- C. Shop Drawings: Provide complete shop drawings showing all devices, device connections, wiring pathways, wire types, headend equipment elevations and associated components prior to installation, for approval by designer.
 - 1. Shop drawings shall be submitted in AutoCad and PDF format.
- D. Quality Control Submittal
 - 1. Test Reports: Submit complete sample test data and reports with exact labels used on cables and patch panels.
 - 2. Certificates
 - a. Manufacturer Certification: Submit certification from manufacturer of products to be installed under this contract certifying that Installer is authorized by manufacturer to install specified products.
 - b. Installer Experience Listing: Submit list of at least 5 completed projects as specified below in "Quality Assurance – Qualifications – Installer."
- E. Contract Closeout Submittal: Comply with requirements of Division 0, including submission of operating and maintenance instructions as item in "Operation and Maintenance Data" manual described in that Section.

1.05 Quality Assurance

- A. All Work shall be installed in a first class, neat and workmanlike manner by skilled Technicians. The quality of the workmanship shall be subject to inspection and approval by authorized owner personnel. Any work found to be of inferior quality and/or workmanship shall be replaced and/or reworked until the approval of the owner is obtained.
- B. Qualifications
 - 1. Installer
 - a. Qualified to cable, terminate and test data network cabling system, coaxial cable system and associated power wiring specified in this Section and section 271000, certified by manufacturer of products to be installed, and completed at least 5 installations of similar size, nature and complexity as specified for this project.
- C. Conditions for Consideration of "Or Equal" Products: Where products are specified by name and accompanied by the term "or equal", the proposed "or equal" product will be considered when the following conditions are satisfied. If all the following conditions are not satisfied, the Design Consultant will return requests without action, except to record noncompliance with these requirements:
 - 1. Proposed product does not require extensive revisions to the Contract Documents.
 - 2. With the exception of the product name or number and manufacturer's name, proposed product conforms with requirements indicated on the Drawings and in the Specifications in every respect and will produce indicated results.
 - 3. The proposed product is fully documented and properly submitted.
 - 4. The proposed product has received necessary approvals of authorities having jurisdiction.
 - 5. The proposed product is compatible with AND has been coordinated with other portions of the Work.
 - 6. Proposed product provides the specified warranty.
 - 7. If the proposed product involves more than one contractor, the proposed product has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
 - 8. The submission is accompanied with detailed comparison of significant qualities of the proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 - 9. The submission is accompanied with a list of similar installations for completed projects with project names and addresses and names and addresses of design consultants and authorities, if requested.
 - 10. The submission is accompanied with the proposed product's Manufacturer signed written statement on Manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents.

1.06 Warranty

- A. Installer's Warranty: Provide manufacturer's system warranty against electrical or mechanical defects for 2 years from date of final acceptance.
- B. A fifteen (15) year Extended Product Warranty and Systems Assurance Warranty for UTP camera wiring system shall be provided by the Manufacturer as follows:
 - 1. System Certification: Upon successful completion of the installation and subsequent inspection, the Authority shall be provided with a numbered certificate, from the manufacturing company, registering the installation.
- C. Manufacturer warranty coverage for fiber systems associated with the CCTV System.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Video Surveillance Equipment (No substitutions and must match the system in the main building)
 - 1. Milestone VMS
 - 2. Milestone NVRs
 - 3. Cisco Meraki Switching Equipment (Owner Furnished, Contractor Installed)
 - 4. Axis Cameras (Basis of Design)
 - a. Acceptable Substitutes
 - i. Avigilon
 - ii. Vicon
 - b. Cameras must be listed as compatible partner products on the Milestone website.
- B. Licensing
 - 1. Provide all necessary VMS, NVR and Camera licenses for the complete system.
- C. Cabling Components for video surveillance systems.
 - 1. UTP Camera Cabling (Plenum Rated)
 - a. CCTV System cabling shall be a distinct color.
 - b. Camera cabling shall provide identical performance to Cat 6 UTP data and voice cabling included in Section 27 10 00 and meet all district performance criteria.
 - c. Third-party verified to meet ANSI/TIA Category 6 requirements. All completed cabling channels fully backwards compatible with requirements of Category 5 and 5e cabling systems.
 - d. See section 27 10 00 for cabling requirements.
 - 2. Patch Panels for CCTV Cabling

- a. All patch panels must provide identical performance to Cat 6 patch panels included in Section 27 10 00 and meet all district performance criteria.
 - b. Shall meet requirements for category 6 (per SCHOOL DISTRICT standards) performance requirements.
 - c. Panels shall contain the number of termination ports required to terminate all LAN and telephone jacks in the service area, plus 20% spare capacity.
 - d. Acceptable units:
 - i. See section 27 10 00.
 - e. Panels shall contain the number of termination ports required to terminate all LAN and telephone jacks in the service area, plus 20% spare capacity.
3. Patch Cables for CCTV Cabling
 - a. Factory terminated and tested UTP patch cables at workstation and equipment cross-connect meeting requirements of ANSI/TIA-568-B for patch cable testing.
- D. CCTV Cameras (Provide latest model)
 1. Exterior cameras shall be an Axis P3268-LVE 8 MP dome pendant/wall mount color units.
 2. Interior units shall be an Axis P3268-LV 8 MP dome ceiling/wall mount with associated mounts.
 3. Interior cameras shall be Axis P3818-PVE 13MP 180 Degree Network Camera dome ceiling/wall mount with associated mounts.
 4. 360° Cameras shall be Axis M3719-PLE MP 15 MP Network Camera dome pendant/wall mount with associated mounts.
 5. Axis License Plate Reader Kit
- E. Pole Enclosure
 1. Altronix WP3 with pole mount kit.
- F. The owner shall provide the system with static IP addresses as needed for multiplexers, and remote master viewing station (PCs) access. Contractor shall supply the Owner with a minimum of (4) copies/licenses of software.
- G. The Owner shall supply remote viewing station PCs.
- H. Provide ceiling or wall mount bracket to support flat screen LCD TVs/all-in-one PCs as indicated on drawings. These TVs shall be fed network cabling and allow for CCTV viewing.
- I. CCTV Wiring
 1. Leviton One Reach system (for site cameras) over 90 meters.
 2. Singlemode Fiber.

3. Cat 6 UTP.
4. 18/2 AWG.
- J. Halo Sensors
 1. Halo Sensor 2C
 2. Cat 6 UTP with surface box and patch cord
 - a. Install in a similar manner to CCTV cameras. See CCTV camera details for information.
 3. Programming
 - a. Integrate / Program with VMS so cameras are activated / alerted when the sensor is alarmed.
 - b. Audible Alarm is triggered when the sensor is alarmed.

PART 3 - EXECUTION

3.01 Examination

- A. Verification of Conditions: Examine conditions under which CCTV cabling and equipment and related components are to be installed in coordination with Installer of materials and components specified in this Section and notify affected Prime Contractors and Design consultant in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected to ensure a safe and timely installation.
 1. When the installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Design consultant written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.
 2. Visit Site to identify and become familiar with existing field conditions and specific requirements of each Site.
 3. Verify all dimensions in field and confirm condition of existing hardware to be utilized.
 4. Confirm space requirements and physical confines of all work areas to ensure that all materials can be installed in indicated spaces.
 5. Confirm all outlet locations and cable pathways and advise Design consultant in writing of any discrepancies or issues in Design described in Contract Documents.

3.02 Preparation

- A. Protection: Provide adequate protection of equipment and hardware before and after installation.
- B. Existing Communications Services: Ensure all telecommunications systems (voice, video and data) remain operational throughout the project.

1. Identify any circuits and/or wiring at the site not shown on T-Drawings and interfering with installation of specified Equipment.
2. Remove all accessible portions of abandoned communications cabling per NEC 800.52. Tag all communications cabling not terminated at both ends but retained for future use.

3.03 Installation

- A. Provide and install all components necessary to install complete telecommunications cabling and equipment systems, including (but is not limited to) connectors, patch cables, terminators, etc...
 1. Cable runs shall be continuous and unbroken from end to end. Splicing of any LAN, Horizontal, Homerun multi conductor cable or coaxial video distribution cable is prohibited.
 2. Secure all horizontal cables within ceiling cavities to the building structure.
 3. Loosely bundle all cables and support from structure at unequal intervals from 5 to 6 feet with spring steel fasteners and cable clip rated for use with high performance cables where cable tray or other support structure has not been provided as indicated on Drawings. All mounting clips shall be seismic type as per BOCA.
 4. Do not violate manufacturer's recommended loadings. Leave 30% capacity for future use of pathway.
 5. Verify all horizontal cable run lengths prior to installation. Re-distribute horizontal cabling to maintain distance requirements and maintain pathway route accessibility.
 6. Do not support cables from ceiling grid T-Bars, grid wire supports or bridle rings. Do not allow cables to touch the ceiling grid.
 7. Install cables in EMT in all unfinished, exposed areas as shown in Design consultant and Architectural roof plans and/or T/TY-Drawings, unless alternate pathways are noted.
 8. Do not secure cables with permanent cable ties. Do not tighten cable bundles in such a way as to cause jacket deformation or damage.
 9. Provide a minimum of 15' of cable slack at camera location and 10 feet at patch panels, unless noted otherwise. Do not coil cable slack.
 10. Place cables in compliance with ANSI/TIA-568.C standards and BICSI recommended methods.
 11. Tight 90-degree bends are unacceptable and use of plastic "cinch-type" tie-wraps are not permitted, in order to prevent damage to cable jacket and compromise the cable's electrical or optical characteristics.
 12. Cable bundles shall be neatly routed with a service loop to provide 10 feet of slack at the cross-connect end and as noted in the T/TY-drawings. Cable bundles shall be secured using only black Velcro cable wraps.

13. Contractor shall not secure service loop in coils, but route in such a manner as to minimize EMI.
- B. Install all exposed cabling in surface raceway by Wiremold, Hubbell or Panduit where in-wall conduit has not been provided. Follow all manufacturers' guidelines requirements regarding bending radius and slack. All bends, offsets and fittings shall be appropriately sized to provide 30% capacity after installation.
- C. Install all cables in accordance with National, state and local codes and ANSI/TIA Standards, and BICSI methods.
 1. Follow manufacturer's guidelines and requirements for all cable termination.
- D. Properly terminate all cables at camera locations and distribution racks. Permanently identify all cables in pullboxes, transition points, and termination points by affixing pre-marked self-adhesive wraps similar to Brady "B-500+ Plastic Cloth Markers."
- E. Permanently identify all system components following ANSI/TIA 606 "Administration Standard for Commercial Telecommunications Infrastructure" with identification format:
 1. Identification: Provide permanent identification labels for patch panels, access panels and entrance facilities.

3.04 Testing

- A. Video Surveillance System
 1. Upon completion of work, all parts of the telecommunications installation shall be tested by the low voltage Contractor and demonstrated free of any defects. Preliminary testing will be permitted but shall not be accepted in lieu of obtaining final test results. Final test results shall be accomplished by the use of proper test equipment for the system being tested.
 2. Re-terminate and re-test any cables or pairs of cables failing end-to-end testing requirements. Replace any faulty cables/pairs or termination devices. Remove all defective cables completely from pathways.
 3. All aspects of the management and control system shall be tested and shown to operate as specified by the manufacturer.

3.05 As-Builts

- A. Accurate as-built drawings shall be provided in electronic and hard copy format.
 1. 3 copies of electronic (CAD) drawings shall be distributed on appropriate media: 1 to construction management, 1 to designers and 1 to the school district.
 2. 3 hard copies of CAD drawings shall be plotted on full size sheets and test results of every installed cable have been given to the construction management for appropriate distribution.
- B. As-builts shall accurately show all devices, wiring, control equipment, rack elevations, equipment elevations and system interconnections.

3.06 Demonstration

A. Video Systems Demonstration

1. 8 Hours of demonstration and training on all aspects of the completely installed systems must be provided for the owner.
 - a. Training shall be video recorded for the owner and given to them after acceptance.
 - b. Training and system demonstration must include all aspects of the system and its operation.
 - c. Additional training, beyond the initial 8 hours, shall be provided for the owner at their request on an hourly rate basis.

3.07 Acceptance

- A. The contractors work shall be considered complete after the following conditions have been met:
1. Cable installation is complete and all cable runs have been tested and documented to be installed according to specifications and drawings.
 2. Equipment installation is complete and all aspects of the system have been shown to operate as per manufacturer's specifications.
 3. A school district security representative has successfully tested the "LIVE" system.
 4. All punch list items have been reconciled.
 5. All disturbed ceiling panels, covers, etc. have been properly reinstalled.
 6. All materials and trash have been removed from the site.
 7. A 2-Year Installers warranty has been given to a district Security representative.
 8. Submit Manufacturers Extended Warranty Application.

END OF SECTION

DIVISION 28 SECTION 28 46 21
ADDRESSABLE FIRE-ALARM SYSTEMS
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SECTION 28 46 21
ADDRESSABLE FIRE-ALARM 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 specification provides the requirements for the installation, programming and configuration of a complete and operational Addressable Intelligent Fire Alarm System Network. The system shall include, but not be limited to: Fire Alarm Control Panel(s), Automatic and Manually Activated Voice Evacuation Alarm Subsystem, Automatic and Manually activated alarm Initiating and Indicating Peripheral Devices and Appliances, conduit, wire and accessories required to furnish a complete and operational Fire Alarm System. System shall include, but not be limited to, the following.
 - 1. Addressable fire-alarm system.
 - 2. Fire-alarm control unit.
 - 3. Manual fire-alarm boxes.
 - 4. System smoke detectors.
 - 5. Duct smoke detectors.
 - 6. Heat detectors.
 - 7. Carbon monoxide detectors.
 - 8. Notification appliances.
 - 9. Device guards.
 - 10. Magnetic door holders.
 - 11. Remote annunciator.
 - 12. Graphic annunciator.
 - 13. Addressable interface device.
 - 14. Digital alarm communicator transmitters (DACTs).
 - 15. Fire-alarm radio transmitters.

- B. The system shall include all wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, alarm initiating devices, alarm indicating devices, and control equipment, and all other accessories and miscellaneous items required for an operating system.
- C. The Fire Alarm System supplied under this specification shall be a microprocessor-based network system. All Control Panel Assemblies and connected Field Appliances shall be both designed and manufactured by the same company, and shall be tested and cross-listed as compatible to ensure that a fully functioning Life Safety System is designed and installed.
- D. All related work specified in other sections shall be properly coordinated with the fire alarm equipment.
- E. Related Sections
 - 1. Division 26 – Electrical

1.3 ALTERNATES

- A. Refer to Division 01 Section, Alternates for description of work under this section affected by alternates.

1.4 DEFINITIONS

- A. DACT: Digital alarm communicator transmitter.
- B. EMT: Electrical Metallic Tubing.
- C. FACP: Fire Alarm Control Panel.
- D. HLI: High Level Interface.
- E. NICET: National Institute for Certification in Engineering Technologies.
- F. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
 - 1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
 - 2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 2. Include rated capacities, operating characteristics, and electrical characteristics.
- B. Shop Drawings: For fire-alarm system.
1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 2. Include plans, elevations, sections, details, and attachments to other work.
 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
 4. Detail assembly and support requirements.
 5. Include voltage drop calculations for notification-appliance circuits.
 6. Include battery-size calculations.
 7. Include input/output matrix.
 8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
 9. Include performance parameters and installation details for each detector.
 10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Show field wiring required for HVAC unit shutdown on alarm.
 - c. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' control system.
 - d. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
 - e. Locate detectors according to manufacturer's written recommendations.
 12. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

13. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
 - a. Secure permits and approvals prior to installation.
 - b. Prior to commencement and after completion of work, notify Authorities Having Jurisdiction.
 - c. Submit letter of approval for installation before requesting acceptance of system.
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.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 01 Section, 017800, *Operation and Maintenance Data*, include the following and deliver copies to authorities having jurisdiction:
 - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

- b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
- c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
- d. Riser diagram.
- e. Device addresses.
- f. Record copy of site-specific software.
- g. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
- h. Manufacturer's required maintenance related to system warranty requirements.
- i. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
 - 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
 - 3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
 - 4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
 - 5. Keys and Tools: One extra set for access to locked or tamperproofed components.
 - 6. Audible and Visual Notification Appliances: One of each type installed.
 - 7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.
- B. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.10 PROJECT CONDITIONS

- A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.
- B. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2. PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice/strobe evacuation.
- B. Automatic sensitivity control of certain smoke detectors.
- C. All components provided shall be listed for use with the selected system.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems.
 - 1. Manual stations.
 - 2. Heat detectors.
 - 3. Smoke detectors.

4. Carbon monoxide detectors.
 5. Automatic sprinkler system water flow.
 6. Fire-extinguishing system operation.
 7. Fire standpipe system.
- B. Fire-alarm signal shall initiate the following actions:
1. Continuously operate alarm notification appliances, including voice evacuation notices.
 2. Identify alarm and specific initiating device at fire-alarm control unit, connected network control panels, and remote annunciators.
 3. Transmit an alarm signal to the remote alarm receiving station.
 4. Unlock electric door locks in designated egress paths.
 5. Release fire and smoke doors held open by magnetic door holders.
 6. Activate voice/alarm communication system.
 7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 9. Activate lighting control.
 10. Activate emergency shutoffs for gas and fuel supplies.
 11. Record events in the system memory.
 12. Indicate device in alarm on the graphic annunciator.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
 2. Duct smoke detector.
 3. Independent fire-detection and -suppression systems.
 4. User disabling of zones or individual devices.
 5. Loss of communication with any panel on the network.

- D. System trouble signal initiation shall be by one or more of the following devices and actions:
 - 1. Open circuits, shorts, and grounds in designated circuits.
 - 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - 3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 - 4. Loss of primary power at fire-alarm control unit.
 - 5. Ground or a single break in internal circuits of fire-alarm control unit.
 - 6. Abnormal ac voltage at fire-alarm control unit.
 - 7. Break in standby battery circuitry.
 - 8. Failure of battery charging.
 - 9. Abnormal position of any switch at fire-alarm control unit or annunciator.
 - 10. Voice signal amplifier failure.
- E. System Supervisory Signal Actions:
 - 1. Initiate notification appliances.
 - 2. Identify specific device initiating the event at fire-alarm control unit, connected network control panels, and remote annunciators.
 - 3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
 - 4. Transmit system status to building management system.
 - 5. Display system status on graphic annunciator.

2.3 FIRE-ALARM CONTROL UNIT

- A. Basis-of-Design Product: Subject to compliance with requirements, provide system and integration with ATC by Simplex to match and integrate with the existing 4100 ES system in the Hodgson Vo-Tech High School.
- B. General Requirements for Fire-Alarm Control Unit:
 - 1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

- a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 - c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
 - d. The FACP shall be listed for connection to a central-station signaling system service.
 - e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
- C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control 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, two line(s) of 40 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
- D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
 1. Pathway Class Designations: NFPA 72, Class B.
 2. Pathway Survivability: Level 0.
 3. Install no more than 50 addressable devices on each signaling-line circuit.
 4. Install fault circuit isolators to comply with circuit performance requirements of NFPA 72 or with manufacturer's written instructions, whichever is more conservative.
 5. Serial Interfaces:
 - a. One dedicated RS 485 port for central-station operation using point ID DACT.
 - b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).

- c. One RS 232 port for PC configuration.
 - d. One RS 232 port for voice evacuation interface.
- E. Smoke-Alarm Verification:
 - 1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 - 2. Activate an 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. Notification-Appliance Circuit:
 - 1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
 - 2. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
- G. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.
- H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.
- I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- J. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided in a separate cabinet.
 - 1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.
 - a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.

- b. Programmable tone and message sequence selection.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear."
 - d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control 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. 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, and 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. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 - 2. Batteries: Sealed lead calcium.
- L. 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.

2.4 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. Single-action mechanism, 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: Key- or wrench-operated switch.
 - 3. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Provide for all manual fire alarm boxes.

2.5 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 four-wire type.
3. 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.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
6. Detector must have functional humidity range within 10 to 90 percent relative humidity.
7. Color: White.

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. 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 for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.

5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.6 CARBON MONOXIDE DETECTORS

- A. General: Carbon monoxide detector listed for connection to fire-alarm system.
 1. Mounting: Adapter plate for outlet box mounting.
 2. Testable by introducing test carbon monoxide into the sensing cell.
 3. Detector shall provide alarm contacts and trouble contacts.
 4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
 5. Comply with UL 2075.
 6. Locate, mount, and wire according to manufacturer's written instructions.
 7. Provide means for addressable connection to fire-alarm system.
 8. Test button simulates an alarm condition.

2.7 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
 1. Temperature sensors shall test for and communicate the sensitivity range of the device.
- B. 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.
 3. Detector must have functional humidity range of [10 to 90] <Insert numbers> percent relative humidity.
 4. Color: White.

2.8 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.
- C. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" or "ALERT" as required is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
 - 1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 - 2. Mounting: Wall or ceiling mounted as indicated on the drawings.
 - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - 4. Flashing shall be in a temporal pattern, synchronized with other units.
 - 5. Strobe Leads: Factory connected to screw terminals.
 - 6. Mounting Faceplate: Factory finished, red for wall mounted devices, white for ceiling mounted devices.
 - 7. Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- D. Voice/Tone Notification Appliances:
 - 1. Comply with UL 1480.
 - 2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.

3. High-Range Units: Rated 2 to 15 W.
 4. Cone Speakers
 - a. Wall Mount: Provide speakers with a 4" mylar cone. Paper type cones are not acceptable. The rear of the speaker shall be completely sealed protecting the cone during and after installation. In - Out screw terminals shall be provided for wiring. Speaker housings shall be white. Speakers shall provide power taps at 1/4w, 1/2w, 1w, and 2w. Speakers shall provide UL confirmed 90 dBA sound output at 2w. Speakers shall mount in a North American 4" electrical box with extension ring using the 2 screws provided with ring. It must not be necessary to completely remove the screws to facilitate mounting.
 - b. Ceiling Mount (4"): Provide speakers with a 4" mylar cone. Paper type cones are not acceptable. The rear of the speaker shall be completely sealed, protecting the cone during and after installation. In-Out screw terminals shall be provided for wiring. Speaker baffles shall be round, steel with white finish. Speakers shall provide power taps at 1/4w, 1/2w, 1w, and 2w. Speakers shall provide UL confirmed 90 dBA sound output at 2w. Speakers shall mount in a North American 4" electrical box with extension ring.
 - c. Ceiling Mount (8"): Provide speakers with an 8" cone. In-Out screw terminals shall be provided for wiring. Speaker baffles shall be round, steel with white finish. Speakers shall provide power taps at 1/2w, 1w, 2w, and 4w. Provide square surface mount boxes with matching white finish.
 - d. High Output: Provide speakers with a 4" mylar cone. Paper type cones are not acceptable. The rear of the speaker shall be completely sealed, protecting the cone during and after installation. In-Out screw terminals shall be provided for wiring. Speaker baffles shall be round, steel with white finish. Speakers shall provide power taps at 1w, 2w, 4w, and 8w. Speakers shall provide UL confirmed 90 dBA sound output at 2w. Speakers shall mount in a North American 4" electrical box with extension
 5. Re-entrant Speakers: Re-entrant speakers shall have a white housing. Power taps shall be provided at 2w, 4w, 8w, and 15w. Re-entrant speakers shall provide 102 dBA peak sound output at 15w. A metal compression driver shall be inherent to the re-entrant speaker. Cone type drivers are not acceptable. Provide weatherproof wall boxes for outdoor mounting.
 6. Matching Transformers: Tap range matched to acoustical environment of speaker location.
- E. Color: ceiling mounted devices shall be white, wall mounted devices shall be red.

2.9 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
 - 1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
 - 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 - 3. Rating: 24-V ac or dc.
- B. Material and Finish: Match door hardware.

2.10 REMOTE ANNUNCIATOR AND GRAPHIC DISPLAY

- 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: Surface cabinet, NEMA 250, Type 1.
- B. Graphic: Provide a graphic drawing of the entire facility showing all barriers, rooms and room numbers so that it is easy to correlate the LCD text with the graphic display ensuring timely response to an alarm. The graphic display shall be mounted in a picture frame and placed above the LCD annunciator. Submit the drawing for engineer approval.
- C. Display Type and Functional Performance: 80 character alphanumeric display with 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.
- D. Key-Operated Switches shall include:
 - 1. Alarm Silence.
 - 2. Trouble Silence.
 - 3. Test.

2.11 ADDRESSABLE INTERFACE DEVICE

- A. General:
 - 1. Include address-setting means on the module.
 - 2. Store an internal identifying code for control panel use to identify the module type.
 - 3. Listed for controlling HVAC fan motor controllers.

- B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall, to circuit-breaker shunt trip for power shutdown.
 - 1. Allow the control panel to switch the relay contacts on command.
 - 2. Have a minimum of two normally open and two normally closed contacts available for field wiring.
- D. Control Module:
 - 1. Operate notification devices.
 - 2. Operate solenoids for use in sprinkler service.
 - 3. Operate door release, sound system mute, and other functions as indicated on the drawings.

2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTER (DACT)

- A. DACT must be acceptable to remote central station and must be listed for fire-alarm use.
- B. IP/Cellular based communicator transmitter shall be acceptable to the remote central station and shall comply with UL 864/NFPA. Contractor shall program and test with communicator contact ID reporting. Provide external antenna and cable. Power connections shall be made to communicator via Fire Alarm Control Panel.
- C. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of IP/Cellular line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report service restoration to the central station. If service is lost on both IP/Cellular lines, transmitter shall initiate the local trouble signal.
- D. Local functions and display at DACT must include the following:
 - 1. Verification that both IP/Cellular lines are available.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with central station or FACU.

- E. Digital data transmission must include the following:
 - 1. Address of alarm-initiating device.
 - 2. Address of supervisory signal.
 - 3. Address of trouble-initiating device.
 - 4. Loss of ac supply.
 - 5. Loss of power.
 - 6. Low battery.
 - 7. Abnormal test signal.
 - 8. Communication bus failure.
- F. Secondary Power: Integral rechargeable battery and automatic charger.
- G. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.13 NETWORK COMMUNICATIONS

- A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.
- B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.
- C. Provide integration gateway using BACnet for connection to building automation system.

2.14 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 device manufacturer.
 - 2. Finish: Paint of color to match the protected device.
- B. Provide for devices in Gymnasium and where indicated on the drawings.

2.15 REMOTE TEST/INDICATING STATION

- A. Provide keyed test switch with LED indicating light for each duct detector. Located below flush in accessible ceiling.

PART 3. EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

3.3 INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.
- C. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
 - 2. Mount manual fire-alarm box on a background of a contrasting color.
 - 3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.

D. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet (9 m).
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches (910 mm) from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Turn over to mechanical contractor for installation in ductwork. Sampling tubes shall be installed so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

G. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

H. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.

J. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.4 PATHWAYS

- A. The Fire Alarm System shall be installed in dedicated raceway, except fire rated type MC cable may be used where concealed above accessible ceilings. The entire system shall be installed in a skillful manner in accordance with approved manufacturers' manuals and wiring diagrams. The Contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation. All wiring shall be of the type recommended by the NEC, approved by local authorities having jurisdiction for the purpose.
 - 1. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in raceway. Raceway shall be conduit in unfinished spaces and surface metal raceway in finished spaces, painted to match existing wall(s).
- B. All junction boxes shall be sprayed red and labeled "Fire Alarm". Wiring color code shall be maintained throughout the installation.

3.5 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section 087100, *Door Hardware*. Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Smoke dampers in air ducts of designated HVAC duct systems.
 - 2. Magnetically held-open doors.
 - 3. Electronically locked doors and access gates.
 - 4. Alarm-initiating connection to activate emergency lighting control.
 - 5. Supervisory connections at valve supervisory switches.
 - 6. Data communication circuits for connection to building management system.
- C. Each addressable analog loop shall be circuited as shown on the drawings but device loading is not to exceed 80% of loop capacity in order to leave space for future devices.
- D. Where it is necessary to interface conventional initiating devices, provide intelligent input modules to supervise Class B zone wiring.

3.6 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section 260553, *Electrical Identification*.
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.7 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.8 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by Architect, Owner and authorities having jurisdiction (if required).
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

- F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.9 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.10 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Provide video recording of training to Owner.

END OF SECTION

SECTION 31 20 00

EARTH MOVING

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. Preparing subgrades for all aspects of construction shown on the plans.
- 2. Excavating and backfilling for buildings and structures.
- 3. Drainage course for concrete slabs-on-grade.
- 4. Subbase course for concrete walks pavements.
- 5. Subbase course and base course for asphalt paving.
- 6. Subsurface drainage backfill for walls and trenches.
- 7. Excavating and backfilling trenches for utilities and pits for buried utility structures.
- 8. Excavating well hole to accommodate elevator-cylinder assembly.
- 9. Warning Tracks
- 10. Pitching Mounds

- B. Related Sections:

- 1. Division 01 Section "Construction Progress Documentation" for recording pre-excavation and earth moving progress.
- 2. Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities; also for temporary site fencing if not in another Section.
- 3. Division 03 Section "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
- 4. Division 14 Section "Hydraulic Elevators" and "Hydraulic Freight Elevators" for excavating well hole to accommodate elevator-cylinder assembly.
- 5. Divisions 21, 22, 23, 26, 27, 28, and 33 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
- 6. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.

7. Division 31 Section "Dewatering" for lowering and disposing of ground water during construction.
8. Division 31 Section "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
9. Division 31 Section "Drilled Concrete Piers and Shafts" for excavation of shafts and disposal of surplus excavated material.
10. Division 32 Section "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
11. Division 32 Section "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.
12. Division 33 Section "Sub-drainage".

- C. Delaware Department of Transportation (DelDOT) Standard Specifications.
- D. Delaware Department of Natural Resources and Environmental Control (DNREC) Sediment and Erosion Control Handbook.

1.3 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.
- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
- G. Fill: Soil materials used to raise existing grades.

1.4 SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
 1. Geotextiles.
 2. Controlled low-strength material, including design mixture.

3. Base Course aggregate
4. Drainage Course aggregate.

1.5 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.
- B. Pre-excavation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Utility Locator Service: Notify Miss Utility (1-800-282-8555) for area where Project is located before beginning earth moving operations.
- C. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 31 Section "Site Clearing are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

1. All on-site borrow, subbase material, base course and drainage course shall be as shown on the plans and in accordance with the DelDOT Standard Specifications.

2.2 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters meeting Mirafi 140N or approved equal.
- B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters meeting Mirafi 600X or approved equal.

2.3 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:
1. Red: Electric.
 2. Yellow: Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems.
 5. Green: Sewer systems.
 6. Green: Sewer systems.

2.4 ATHLETIC FIELDS

- A. Pea Gravel Choke Layer: Use a washed uniform pea gravel, maximum 3/8" size, as choke/separator layer between crushed aggregate base and all skinned infield areas, as detailed.
- B. "Skinned" Infield Mix: At all infield areas, provide 4 -1/2" "Martins Infield Mix", Martins Quarry, Bechtelsville, PA (610) 367-2011, or approved equal as Diamond Tex, etc. Submit samples for approval by Owner and Architect.
- C. Warning Track: Provide 4" manufacturer's mix specifically blended for this use, as detailed. Submit samples for approval by Owner and Architect.
- D. Clay Mix for Pitching Mounds and Batter's Box Area: Use bag clay specifically formulated for this use in high-wear forward area of mound, and at batter's box area, placed as top 4" of material, and covering the forward 30% of the mound, as well as entire batter's box area. Submit samples for approval by Owner and Architect.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXPLOSIVES

- A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

- A. All excavation shall be as shown on the plans and in accordance with the DelDOT Standard Specifications and the DNREC Sediment and Erosion Control Handbook.

3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
 - 1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 - 2. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
 - 1. Clearance: 12 inches each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

3.8 SUBGRADE INSPECTION

- A. Notify Architect/Engineer/Construction Manager when excavations have reached required subgrade.
- B. If Architect/Engineer/Construction Manager determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
 - 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

- A. Place and compact backfill in excavations promptly as shown on the plans and in accordance with the DelDOT Specifications.

3.12 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section Cast-in-Place Concrete.
- D. Backfill voids with satisfactory soil while removing shoring and bracing.
- E. Place and compact final backfill of satisfactory soil to final subgrade elevation.

3.13 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 1. Under grass and planted areas, use satisfactory soil material.
 2. Under walks and pavements, use satisfactory soil material.
 3. Under steps and ramps, use engineered fill.
 4. Under building slabs, use engineered fill.

5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place and compact fill as shown on the plans and in accordance with the DelDOT Standard Specifications.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

3.17 SUBSURFACE DRAINAGE

A. Sub-drainage Pipe: Specified in Division 33 Section "Sub-drainage."

B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade.

3.18 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place as shown on the plans and in accordance with the DelDOT Standard Specifications.

3.19 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.

3.20 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
 - 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft or less of paved area or building slab, but in no case fewer than three tests.
 - 2. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; re-compact and retest until specified compaction is obtained.

3.21 INFIELD "SKINNED AREAS"

- A. Rough and finish grade the field, establishing precision grade at base lines and corners, and pitcher's mound. Subgrade shall be 10" below finished grade of skinned area, except for pitching mound, which shall be 6" below finished grade. Trim edges of excavated subgrade with vertical faces.
- B. Finish grade a 4-1/2" thickness of the mix, spread uniformly over the rough grade and compacted to a 4" thickness with a light power roller. Cover rolled mixture with a 1/2" thick layer of the mix, and roll lightly, then rake to a uniformly smooth surface, removing all stones.

- C. Finish grade of skinned area shall be completely flush with surrounding topsoiled areas, so as to show no change in grade at the juncture of these areas.
- D. Repair all low spots, depressions, wash-outs within 30 days of installation to Owner's satisfaction.

3.22 WARNING TRACKS

- A. Strip topsoil and excavate 4" for track area, per plan. Track shall be 15 Feet wide. Extend track 1' beyond line of chain link fence as shown. Slope subgrade at 2.0% toward fence.
- B. Trim edges of excavated soil with clean, vertical faces.
- C. Provide the warning track material, spread evenly and compacted.
- D. Repair all low spots, depressions, wash-outs within 30 days of installation to Owner's satisfaction.

3.23 PITCHING MOUNDS

- A. Construct with clay base soil material, shaping and compacting. Utilize manufactured clay for top 3" at forward portion of mound (pitchers landing area), as detailed. Construct top 3" of batter's box with equal clay material. (12' wide x 16' deep, encompassing batters box and catcher's area)

3.24 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and re-compact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.25 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.
- B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.
 - 1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00

SECTION 31 23 00 - EXCAVATION AND BACKFILL FOR PIPELINES AND STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section.

1.2 SUMMARY

- A. Work included in this section shall include furnishing all labor, materials, and equipment necessary for the Contractor to perform all excavation, backfilling, filling, grubbing and grading required for construction and installation of pipelines, pavements, structures and appurtenances and to perform general site grading. Excavation shall include removal of pavement, concrete, rock, earth and debris, regardless of character. Trenches and excavations shall be sheeted, shored and braced by the Contractor, as necessary to allow construction and provide safe working conditions. Additionally, the Contractor shall be responsible for maintaining a dry excavation by dewatering. He shall also locate, support and protect existing utilities and structures encountered in the work, provide traffic control where required, dispose of surplus and unsuitable excavated materials and restore backfilled areas to original condition or as required by the drawings and specifications. All backfilled and restored areas shall be maintained by the Contractor, in a proper condition, for the duration of the project.
- B. The Contractor is responsible for direct or indirect damage to existing structures, pipelines, conduits, utility poles, wires and utilities of every description in the vicinity of his work whether above or below ground, or that may be encountered in trench or structure excavation, whether or not such utilities are shown on the Drawings. This responsibility shall include the cost of protection by sheeting, bracing, hand excavation, when warranted, and the expense to repair or replace any existing facility damaged directly or indirectly by construction activities under this contract.
- C. The Contractor shall verify the location, size and elevation of all existing utilities at the various points of connection and/or crossings prior to starting any work. Any discrepancies in locations or elevations shall be brought immediately to the attention of the Engineer in order that the designs may be adjusted accordingly. Damages suffered or additional costs incurred by the Contractor as a result of his failure to conform to the requirements of this paragraph shall be the sole responsibility of the Contractor. Connections to existing utilities shall be made by the Contractor at such a time and in such a manner as the Engineer may direct, and the cost shall be included in the price bid for pipeline and structures, unless otherwise defined elsewhere in the proposal.
- D. RELATED SECTIONS
 - 1. Section 31 25 00: "Erosion and Sediment Control".

1.3 DEFINITIONS

- A. Excavation consists of the removal of material encountered to sub-grade elevations and the reuse or disposal of materials removed as required.
- B. Sub-grade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below sub-base, drainage fill, or topsoil materials.
- C. Borrow: Soil material obtained off-site when sufficient approved soil material is not available from excavations.
- D. Sub-base Course: The layer placed between the sub-grade and base course in a paving system, or the layer placed between the sub-grade and surface of a pavement or walk.
- E. Base Course: The layer placed between the sub-base and surface pavement in a paving system.
- F. Unauthorized excavation consists of removing materials beyond indicated sub-grade elevations or dimensions without direction by the Engineer. Unauthorized excavation, as well as remedial work directed by the Engineer, shall be at the Contractor's expense.
- G. Structures: Buildings, footings, foundations, retaining walls, slabs, pump stations, manholes, catch basins, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below ground surface.
- H. Utilities include on-site overhead utilities, underground pipes, conduits, ducts, and cables, as well as underground services within building lines.

1.4 SUBMITTALS

- A. Submit for approval certified gradations, plasticity index and soil classification of each type of material proposed for use.
- B. Submit copies of all laboratory and field soil test results directly to the Engineer within 24 hours of completion of test.

1.5 QUALITY ASSURANCE

- A. Compaction:
 - 1. Top 12" of sub-grade and each 8" loose layer of backfill and fill under structures. Building slabs, steps, and sidewalks shall be compacted to 95 percent maximum density, ASTM D 698, unless otherwise noted.
 - 2. Top 12" of sub-grade and each 8" base layer of backfill and fill under structures. Pavements and wastewater structure base slabs shall be compacted to 95% maximum density, ASTM D 1557, unless otherwise noted.

3. Top 6" of sub-grade and each layer of backfill under lawns or unpaved areas, shall be compacted to 90 percent maximum density, ASTM D 698.
 4. Contractor may use ASTM D 1557 in lieu of ASTM D 698 in all cases.
- B. Grading Tolerances Outside Building Lines:
1. Lawns, unpaved areas, walks, and embankments, plus or minus 1 inch.
 2. Stone and asphalt pavements, plus or minus 1/2 inch.
- C. Grading Tolerance for Fill Under Building Slabs: plus or minus 1/4 inch measured with a 10' straightedge.

1.6 PROJECT CONDITIONS

- A. Contact the Owner and Miss Utility at 1-800-441-8355 at least 48 hours prior to beginning installations.
- B. Existing Utilities: Do not interrupt existing utilities, electrical, yard piping, etc. serving facilities occupied by the Owner or others except when permitted in writing by the Engineer and then only after acceptable temporary utility services have been provided. Provide a minimum 48 hours notice to the Engineer and receive written notice to proceed before interrupting the utility.
- C. All soil testing services shall be performed by an independent testing agency coordinated and paid for by the Contractor.

PART 2 - PRODUCTS

2.1 GENERAL

- A. No classification of excavated materials will be made. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work, regardless of the type, character, composition, or condition thereof.
- B. Materials used for backfill and fill shall be free of clay clods, rock or gravel larger than 2 inches in any dimension and debris, waste, frozen materials, and other deleterious matter.

2.2 SOIL MATERIALS

- A. General: Provide approved satisfactory borrow soil materials from off-site when sufficient approved soil materials are not available from excavations. Materials shall comply with the following specifications and Maryland State Highway Administration Standard Specification.

- B. Satisfactory Soil Materials: ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, SC, and SM; free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter. Satisfactory soil materials shall conform to Maryland State Highway Administration Section 916.01, Select Borrow.
- C. Unsatisfactory Soil Materials: ASTM D 2487 soil classification groups GC, ML, MH, CL, CH, OL, OH, and PT.
- D. Backfill and Fill Materials: Satisfactory soil materials unless otherwise approved by the Engineer.
- E. Base Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand, conforming to Maryland State Highway Administration Section 901 for Graded Aggregate Base.
- F. Structural Fill: ASTM D 2487 Soil Classification Groups SM and/or SC.
- G. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, ASTM D448, coarse aggregate grading size 57 conforming to AASHTO M43 type No. 57.
- H. Pipe Bedding Material: Artificial foundation using drainage fill.
- I. No soil material shall be considered unsatisfactory due to moisture content. Contractor shall dry soils with excess moisture or add additional moisture to any material at no additional cost to the Owner.

2.3 SUITABLE BACKFILL

All suitable materials removed from the excavation shall be used for backfill and/or sub-grade replacements of unsuitable materials. No excavated material shall be wasted without permission of the Engineer. As material is excavated it shall be separated into suitable and unsuitable material stockpiles for reuse or disposal as the case may be. No payment for select backfill under contingencies will be approved until all suitable soils from excavations have been expended.

2.4 SELECT BACKFILL

- A. Should the Contractor encounter unsuitable material during excavation, he shall remove and dispose of such material at a location approved by the Engineer. The cost of such disposal shall be included in the appropriate prices bid.
- B. Should sufficient suitable material from excavations on the project not be available for backfill, the Contractor shall furnish Select Backfill upon written approval of the Engineer. Select Backfill shall conform to the requirements for satisfactory soil materials per section 2.2. Contractor shall pay for all testing necessary for approval of the select materials including sampling, sieve analysis, Atterberg limits and classification.

- C. Payment for removal of unsuitable sub-grade material and replacement with select backfill as authorized by the Engineer will be made at the unit price bid for the material placed within the payment trench width detailed on the project plans and for the length and depth approved. For backfill around structures, select backfill payment volume will be limited to an area 3'0" outside the foremost edge of the structure on all sides and from the bottom of the structure to the ground surface. This item is for unsuitable sub-grade and backfill material only and does not apply to embankment or fill material required for project construction which is to be included in the lump sum price for the treatment plant.

2.5 ARTIFICIAL FOUNDATION

Artificial Foundation and pipe bedding material shall consist of washed, uniformly graded mixture of uncrushed gravel free from angular edges grading size 57 conforming to Maryland State Highway Administration Section 901.

2.6 TOPSOIL

Topsoil shall mean friable clay loam surface soil suitable for use in grass planting. It occurs as a thin soil layer covering naturally well-drained land covered by a heavy growth of grass or which has been covered with a heavy growth of grass during the latest growing period before start of construction. In addition, the topsoil shall be reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and shall be free from stones, stumps, and other objects larger than 2 inches in any dimension, roots, and other objectionable material.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Protect sub-grades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.
- C. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.2 STRIPPING

- A. Remove all organic material from the roadways and building construction areas. Stockpile all suitable material for reuse as topsoil during final grading and stabilization process. Remove all unsuitable materials from the site at the end of the project.
- B. The depth of stripping shall be a minimum of 6 inches or as required by actual field conditions.

3.3 GENERAL EXCAVATION

- A. Explosives: The use of explosives shall not be permitted on this project.
- B. Unclassified Excavation: Excavation is unclassified and includes excavation to required sub-grade elevations regardless of the character of materials and obstructions encountered.
- C. Excavated materials shall be segregated as they are excavated, with the suitable and unsuitable materials and topsoil being piled separately according to designated use specified in Part 2 of this section. All suitable materials shall be used for backfill or embankment. Suitable wet materials shall be dried to optimum moisture content at the Contractor's expense and be used for backfill or embankment. All unsuitable materials shall be removed, at the Contractor's expense and disposed of after the project is completed at a location approved by the Engineer. No excavated material shall be deposited at any time so as to endanger partly finished structures either by direct pressure, or indirectly by overloading banks contiguous to the operation.
- D. The Contractor shall employ the services of a soil testing agency acceptable to the Engineer to determine adequacy of excavated material for reuse as backfill or embankment. Submit results of testing to Engineer for approval.
- E. Excavation may be moved directly to areas of fill and embankment. However, the Contractor must schedule the work so that all construction areas will remain free-draining, without any ponding of water. Temporary ditches and dewatering operations shall be constructed, if necessary, to accomplish this end. If, at the time of excavation, it is not possible to place material in its proper location as fill or embankment, it shall be stockpiled for later use and shall be stabilized in an approved manner if not to be utilized within 14 calendar days.

3.4 APPROVAL OF SUBGRADE

- A. Notify Engineer when excavations have reached required sub-grade.
- B. Proof roll sub-grade areas to receive bituminous paving with a loaded tandem wheel dump truck in the presence of the Engineer or his representative prior to compaction to locate any soft areas. Provide penetrometer testing for building, basin and other structural sub-grades.
- C. When Engineer determines that unforeseen unsatisfactory soil or soft areas are present, continue excavation and replace with compacted backfill or fill material as directed.
- D. Reconstruct sub-grades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Engineer at no additional cost.

3.5 VERIFICATION OF SOIL BEARING CAPACITY

The Contractor shall be responsible for testing of the available soil bearing capacity below the

foundation of any structure. He shall arrange for such testing by an independent agency approved by the Engineer. The Contractor shall pay the agency for at least two (2) three foot deep penetrometer tests and subsequent bearing capacity evaluation as specified on the drawings per 1000 S.F. area, minimum one (1) per individual structure or basin. If the required value as stated in the structural notes is not reached, the Contractor shall compact the sub-grade by means of vibratory rollers and pay and arrange for retesting until the required values are met.

3.6 UNAUTHORIZED EXCAVATION

Fill unauthorized excavation under foundations or wall footings by extending indicated bottom elevation of concrete foundation or footing to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position when acceptable to the Engineer. Fill unauthorized excavations under other construction as directed by the Engineer.

3.7 FILL AND EMBANKMENT

A. Contractor shall furnish and place, within the prices bid and at no additional cost to the Owner, all structural fill to meet the construction requirements of the Contract Documents. Only material meeting the specifications will be approved for use. Contractor shall dispose of excess material off site within prices bid.

B. Structural Fill and Embankment

1. Structural Fill and Embankment for roadways, embankment, and structures shall be constructed of friable, compatible material from excavation or borrow. The material shall be free from debris, organic matter or excessive amounts of clay. Soils shall be classified as SM and/or SC (Unified Soils Classification).
2. Structural fills shall be constructed in loose layers not exceeding 8 inches loose thickness for the full width of the cross section. Construction shall proceed in such manner as to keep all areas free-draining, without ponding of water. Construction shall be suspended when satisfactory results cannot be achieved on account of wet or freezing weather.
3. Each layer of fill or embankment shall be compacted to not less than 95 percent of maximum density as determined by ASTM D 698, by means of multiple-wheel pneumatic tired rollers, vibratory rollers or other approved types, unless otherwise noted.
4. Compacting shall be continued until the required compaction has been achieved. Displacement of soil under or ahead of the roller shall be sufficient evidence that required compaction has not been achieved.
5. Fills and embankments shall be carried to the finished grades shown, less the necessary allowance for pavement, topsoiling, etc. Fine grade all areas prior to construction of finishing courses.
6. Frozen materials shall not be placed in fills and embankments. Any materials which freeze after being placed shall not be covered over until it has completely

thawed.

7. Embankment and fill material which may be lost or displaced as a result of natural causes such as storms, cloudbursts, etc., shall be replaced by the Contractor with acceptable material at no additional cost to the Owner.

3.8 PIPELINE TRENCH EXCAVATION

- A. The Contractor shall excavate, maintain and backfill all excavation necessary for completing the work under the contract. Unless otherwise specified or approved, excavation shall be open cut. No extra compensation will be allowed for hand excavation and backfill necessary to complete the work as required by the Engineer.
- B. Trenches shall be excavated to the necessary width and depth, as shown on the drawings and as required for the placement and removal of protective sheeting, pull boxes, etc. No extra compensation will be allowed for trenches wider than that detailed on the drawings.
- C. The sides of the trenches shall be practically plumb and shall not be sloped unless approved in writing by the Engineer. Trench sides shall be supported or sheeted as required to protect pavement surfaces, curbing, utilities, structures, etc., and required for safety. Safety regulations shall be as required by State safety codes and OSHA. Refer to Part 3.17 of this section for sheeting requirements.
- D. In paved areas, the Contractor shall remove the paving only as necessary for the excavation of the trench or as detailed. Pavement edges at the trench shall be saw cut neat, straight, and to the full depth of paving prior to the start of any excavation. Should the Contractor disturb or damage pavement for a greater width than detailed on the drawings or should pavement damage result from cave-ins, settlement, etc., the Contractor shall replace such paving at his own expense.
- E. In non-paved areas, strip surface vegetation and suitable topsoil and place in stock piles which are separated from the trench excavated materials. Topsoil shall not be used for general trench refill.
- F. The excavation of all trenches shall be fully completed at least twenty (20) feet in advance of pipe laying, unless otherwise authorized or directed. The Engineer may require the backfilling of open trench, over completed pipelines, or ahead of the pipe laying operation, if in his judgment such action is necessary, and the Contractor shall have no claim for extra compensation.
- G. Should work be stopped for any reason and any excavation is left open for an unreasonable length of time, the Contractor shall refill the excavation at his own expense if so directed by the Engineer, the Inspector or Owner. He shall not reopen the excavation until he is ready to complete the facility. Should the Contractor refuse or fail to refill any excavation completely within forty-eight (48) hours, or immediately if it poses a safety hazard, after a proper notice has been given by the Engineer or Inspector, the Owner shall be authorized to do the work. The resulting expenses shall be deducted from monies due the Contractor.
- H. The Contractor shall complete excavation as nearly as practicable to the lines of the pipeline to be installed as detailed. All cavities in the bottom of the trench shall be filled

to the required level with compacted crushed stone or gravel. Unless the cavities have been made on direction of the Engineer and classified as "Excavation Below Sub-grade" for unsuitable material, no extra compensation shall be due the Contractor.

- I. Excavated materials shall be graded, hauled, stored and protected as such material found suitable will be required for backfilling, or other purposes. Material classified as unsuitable shall be disposed of by the Contractor at a location approved by the Engineer. Hauling of excavated materials for any purpose shall not entitle the Contractor to additional compensation. Only those excavated materials designated by the Owner shall become property of the Contractor.
- J. All stockpiled materials shall be placed in such a way to prevent damage to the trench, structures, drainage areas or private property. Excavated materials shall not be placed on private property unless written permission is obtained from the property Owner by the Contractor.
- K. The Contractor shall remove, relocate or protect all structures including but not limited to signs, mailboxes, overhead and buried utilities and other structure in the path of work as required for construction whether shown on drawings or not. No extra compensation will be allowed for property damage, injury or loss of time due to obstructions encountered which are not shown on the plans.
- L. The Contractor shall be responsible for any damage to curb, gutter, sidewalk, traffic control devices, pavement material, pavement markings and lawns. Any damage resulting directly or indirectly during construction shall be replaced in kind by the Contractor without additional compensation. The reuse of disturbed curb, gutter or sidewalk is prohibited. New sections shall be installed to the nearest undisturbed joint. Cost for replacement shall be included in the appropriate price bid.

3.9 PIPELINE TRENCH BACKFILL

- A. Materials excavated from the trench except topsoil shall be used for trench backfill, provided that, in the opinion of the Engineer, the excavated material is suitable for this purpose. Backfill material shall be free from large lumps, pavement, pieces of concrete and stones.
- B. Suitable material, as approved by the Engineer, shall be carefully deposited in the trench by methods which will not damage or disturb the pipeline or structure, and shall be solidly tamped around the pipe or structure. Backfill material shall be placed in 6" loose layers and hand tamped until the top of pipe is covered by at least 12 inches of compacted material. Above this point, backfill material shall be placed in 8" loose layers. Compaction for 8" layers shall be accomplished by mechanical tampers or other approved methods. Care shall be taken in the use of mechanical tampers not to injure or move the pipe or to cause the pipe to be supported unevenly. Each layer shall be mechanically tamped for the full trench width unless an alternative method is approved in writing by the Engineer.
- C. Every backfill layer shall be compacted to 95% of maximum density at -2 to +2% of optimum moisture content as determined by the Standard Proctor Test, ASTM D-698. Materials containing an excess of moisture shall be permitted to dry until the moisture

content is within the specified range. Materials too dry shall be wetted uniformly, at the Contractor's expense, until the moisture content is in the specified range.

- D. No compacting shall be done when the material is too wet to be compacted properly. At such times, the work shall be suspended until the backfill materials have dried sufficiently to permit proper compaction or such other precautions shall be taken as may be necessary to obtain proper compaction. The Contractor is responsible for hauling, storing and drying of excavated material to be used in backfill operations within the prices bid.
- E. The Contractor shall, at his own expense, maintain all refilled excavations in proper condition. Trench surfaces shall be reshaped when necessary. If the Contractor fails to make repairs within forty-eight (48) hours after receipt of written notice from the Owner, the Owner may refill said depression wherever necessary and the cost of so doing will be retained from any monies due or to become due the Contractor under the Contract. The Contractor shall be fully responsible for any injury or damage that may result from lack of maintenance of any refilled excavation at any time prior to final acceptance.
- F. All unauthorized excavations made by the Contractor shall be immediately backfilled in accordance with the requirements of the specifications for trench backfill at the Contractor's expense.
- G. After completion of backfilling, all material not used shall be disposed of as approved by the Engineer, and all places on the line of the work shall be left clean and in good condition. This cleaning up shall be done by the Contractor without extra compensation. If he fails to do this work within a reasonable time after receipt of notice, it will be performed by the Owner, and the cost will be retained from the monies due the Contractor under the Contract.
- H. No backfilling of pipelines will be allowed until measurements of pipe and an inspection has been performed by the Owner's representative, and until the Engineer has authorized the backfill. Any unauthorized backfill of pipelines shall be uncovered by the Contractor at his expense if required by the Engineer.

3.10 EXCAVATION FOR STRUCTURES

- A. Excavate for structures, walls, foundations, footings, etc., to the depth and width required for construction and stripping of forms. Structural excavation shall consist of the excavation of all earth, rock, boulders, existing concrete and masonry foundations and walls, and all other materials encountered regardless of type, which the Contractor may encounter. No extra compensation will be allowed for excavation greater than 3'0" outside the most exterior point of the structure.
- B. The sides of the excavation shall be practically plumb and shall not be sloped unless approved in writing by the Engineer. Sides shall be supported or sheeted as required to protect pavement surfaces, curbing, utilities, structures, etc., and required for safety. Safety regulations shall be as required by State safety codes and OSHA. Refer to Part 3.17 of this section for Sheet piling, Shoring, and Bracing.

- C. In paved areas, the Contractor shall remove the paving only as necessary for the excavation of the structure or as detailed. Pavement edges at the structure shall be saw cut neat, straight, and to the full depth of paving prior to the start of any excavation. Should the Contractor disturb or damage pavement for a greater width than detailed on the drawings or should pavement damage result from cave-ins, settlement, etc., the Contractor shall replace such paving at his own expense.
- D. In non-paved areas, strip surface vegetation and suitable topsoil and place in stock piles which are separated from the trench excavated materials. Topsoil shall not be used for general trench refill.
- E. Should work be stopped for any reason and any excavation is left open for an unreasonable length of time, the Contractor shall refill the excavation at his own expense if so directed by the Engineer, the Inspector or the Owner. He shall not reopen the excavation until he is ready to complete the facility. Should the Contractor refuse or fail to refill any excavation completely within forty-eight (48) hours, or immediately if it poses a safety hazard, after a proper notice has been given by the Engineer or Inspector, the Owner shall be authorized to do the work. The resulting expenses shall be deducted from monies due the Contractor.
- F. The Contractor shall complete excavation as nearly as practicable to the depths of the structure to be installed as detailed. All cavities in the bottom of the excavation shall be filled to the required level with compacted crushed stone or gravel. Unless the cavities have been made on direction of the Engineer and classified as "Excavation Below Sub-grade" for unsuitable material, no extra compensation shall be due the Contractor.
- G. Excavated materials shall be graded, hauled, stored and protected as such material found suitable will be required for backfilling, or other purposes. Material classified as unsuitable shall be disposed of by the Contractor at the end of the project at a location approved by the Engineer. Hauling of excavated materials for any purpose shall not entitle the Contractor to additional compensation. Only those excavated materials designated by the Owner shall become property of the Contractor.
- H. All stockpiled materials shall be placed in such a way to prevent damage to the structures, drainage areas or private property. Excavated materials shall not be placed on private property unless written permission is obtained from the property Owner by the Contractor.
- I. The Contractor shall remove, relocate or protect all structures including but not limited to signs, mailboxes, overhead and buried utilities and other structure in the path of work as required for construction whether shown on drawings or not. No extra compensation will be allowed for property damage, injury or loss of time due to obstructions encountered which are not shown on the plans.
- J. The Contractor shall be responsible for any damage to curb, gutter, sidewalk, traffic control devices, pavement material, pavement markings and lawns. Any damage resulting directly or indirectly during construction shall be replaced in kind by the Contractor without additional compensation. The reuse of disturbed curb, gutter or sidewalk is prohibited. New sections shall be installed to the nearest undisturbed joint. Cost for replacement shall be included in the appropriate price bid.

3.11 BACKFILL FOR STRUCTURES

- A. Backfill around structures with suitable material from the excavation to the original surface grades shown on the plans or defined by the Engineer. If additional material is needed to backfill around the structure, Special Off-Site Backfill approved by the Engineer shall be furnished and placed by the Contractor within the lump sum price bid.
- B. No backfill shall be placed against new concrete or masonry structures until properly cured.
- C. Backfill shall be placed in eight (8) inch loose layers and compacted by mechanical tampers or other approved methods. Compaction shall conform to the requirements for compaction already set forth in this specification.
- D. The Contractor shall exercise caution in backfill and compaction to prevent damage to structures.

3.12 GRADING

A. PREPARATION

- 1. Prepare subsoil surface for finish grading by dressing and shaping to provide for uniform placement of topsoil or other surface as specified.
- 2. Cut and fill to within 0.2 foot of the correct sub-grade elevations. Set elevation to top of sub-grade under paved areas to bottom of the pavement base. Set elevation of the top of sub-grade under areas to receive topsoil, 4 inches below finished grades.
- 3. Furnish additional material required for rough grading, backfill or fill.
- 4. Remove surface rock or other foreign objects exceeding 2 inches in greater dimension. Dispose of such rock and debris in a lawful manner off-site.
- 5. Provide smooth transition between existing adjacent grades and new grades.

B. PERFORMANCE

- 1. Placement of Topsoil: Place topsoil over areas indicated for new grading contours. However, before topsoil construction work in these areas shall have been completed. Observe precautions as follows:
 - a. Do not place topsoil over areas indicated to receive paving or sidewalk.
 - b. Do not work topsoil or liner material while frozen or wet. Do not work materials in a dusting condition but moisten same to prevent a dust nuisance.
 - c. Scarify subsoil to a depth of 2 inches for bonding topsoil with subsoil.
 - d. On sloped areas, work topsoil or liner material into subsoil to blend so as to eliminate any semblance of slip-planing between the two soils; but leave a sufficient cover of topsoil to insure seed germination. Perform such blending of soils by ridging or serrating the subsoil on the slopes.

- e. Place topsoil as needed for dressing-up minor depressions due to settling and erosion and to eliminate any other minor regularities.
2. Finished Elevations and Lines of Grassed Areas: Grade topsoiled areas of the site to within a tolerance of 1 inch of the elevations and lines indicated and in accordance with the following.
- a. Grade a uniform longitudinal fall in swales and other surface drainage areas to provide a drainage flow line that can easily be maintained and traversed with normal lawn maintenance equipment.
 - b. Establish finish grade of topsoil ½ to ¾ inches below top of abutting walks or paving to provide positive drainage of same.
 - c. Place and grade topsoil to a depth not less than 4 inches nor greater than 12 inches.
 - d. Compaction: Compact finish grades as the final operation using a light roller weighing not over 120 pounds per foot-width of roller.
 - e. Tillage: Till finish graded soil over areas indicated for lawn regardless of type of lawn work performed. Use equipment and methods common to such work and till soil to a two inch depth minimum.
 - f. Seed and mulch in accordance with Section 323400 and the project plans.

3.13 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. Compaction and Density testing shall be coordinated by the Contractor with the Engineer and performed by an independent testing agency approved by the Engineer. The Contractor shall pay the testing laboratory for all tests performed inclusive of sample collection, preparation and transportation. Whenever test results indicate compaction densities less than specified, the Contractor shall, at his own expense, secure the specified compaction and subsequent retesting with methods approved by the Engineer. The testing agency, so employed by the Contractor, shall submit a copy of all testing reports directly to the Engineer. Each report shall contain the project identification name and number, name of Contractor, name of testing agency, and location of sample tested by station, location and depth as minimum.
- B. Perform field in-place density tests according to ASTM D 1556 (sand cone method) ASTM D 2167 (rubber balloon method) or ASTM D 2937 (drive cylinder method), as applicable.
 - 1. Field in-place density tests may also be performed by the nuclear method according to ASTM D 2922, provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556. With each density calibration check, check the calibration curves furnished with the moisture gages according to ASTM D 3017.
- C. When field in-place density tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each different type of material encountered, and at intervals as directed by the Engineer.

- D. Footing Sub-grade: At footing sub-grades, perform at least one test of each soil stratum to verify design bearing capacities. Subsequent verification and approval of other footing sub-grades may be based on a visual comparison of each sub-grade with related tested strata when acceptable to the Engineer.
- E. Paved and Building Slab Areas: At sub-grade and at each compacted fill and backfill layer, perform at least one field in-place density test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
- F. Foundation Wall Backfill: In each compacted backfill layer, perform at least one field in-place density test for each 100 feet or less of wall length, but no fewer than two tests along a wall face.
- G. Trench Backfill: In each compacted initial and final backfill layer, perform at least one field in-place density test for each 200 feet or less of trench, but no fewer than two tests.
- H. When testing agency reports that sub-grades, fills, or backfills are below specified density, scarify and moisten or aerate, or remove and replace soil to the depth required, recompact and retest until required density is obtained.

3.14 MISCELLANEOUS EXCAVATION AND BACKFILL

- A. The Contractor shall do such miscellaneous excavation as may be necessary or directed. Such excavation shall be subject to the same conditions and requirements as specified for trench excavation.
- B. Miscellaneous Excavation shall include the digging of test pits, extra width of trench beyond the specified trench payment width made necessary by change in its alignment, or excavation for any special structures outside the trench that may not be shown on the drawings or described in the specifications, where such excavation is done at the direction of the Engineer.
- C. Test pits shall be dug by the Contractor whenever directed to determine location, depth or materials of existing utilities. The depth and size of test pits shall be such as required by the Engineer.
- D. Test pits shall also be dug by the Contractor, as authorized by the Engineer, along the lines of the trenches as shown on the drawings in advance of the excavation, or prior to use of mechanical moles, for the purpose of satisfying himself as to the location and elevation of underground obstructions or conditions.
- E. Test pits dug which are noted on the project plans or in advance of pipe laying operations to verify utility locations or additional excavation required to use sheeting or trench boxes shall be included in the prices bid in the proposal.

3.15 EXCAVATION BELOW SUBGRADE AND GRAVEL REFILL

- A. Materials below the excavation limit for pipelines and structures (below sub-grade), which in the judgment of the Engineer should be removed, shall be removed as directed. All spaces created by the removal of unsuitable material below sub-grade shall be refilled and compacted with crushed stone or gravel, specified in paragraph 2.5 of this section. Payment for Excavation Below Sub-grade and Gravel Refill shall be made at the unit price bid only for the length width and depth authorized.
- B. Should the Contractor elect to excavate suitable material below sub-grade and install stone for the purpose of securing a dry trench bottom, in lieu of dewatering by mechanical methods, no payment will be made for Excavation Below Sub-grade and Gravel Refill.

3.16 DEWATERING

- A. All excavations must be kept free of water below the sub-grade of the work while work is in progress. This may be accomplished by ordinary pumping methods or by well points, whichever will produce the required results. The Contractor shall obtain all necessary dewatering permits at no additional expense. Upon removal of dewatering equipment, the Contractor shall backfill all holes and restore disturbed areas to their original condition.
- B. Dewatering for the structures and pipelines shall commence when groundwater is first encountered and shall be continued until such time as backfill has been completed. No concrete or pipe shall be laid in water nor shall water be allowed to rise over them until the concrete or mortar has set at least eight (8) hours. Groundwater shall not be allowed to rise around the pipe until the trench is backfilled.
- C. The Contractor shall dispose of the water from the work in a suitable manner without damage to adjacent property. No water shall be drained into work built or under construction without prior consent of the Engineer. Water shall be disposed of in such a manner as not to be a menace to the Public Health.
- D. In the event the Contractor's dewatering operations affect any water supplies within the project area, the Contractor shall take whatever steps that may be required to provide uninterrupted water service.
- E. The Contractor shall remove any siltation deposits in storm sewer systems, resulting from his dewatering or construction operations. He shall also be responsible for conveyance of dewatering flows and for erosion and sediment control.

3.17 SHEETING, SHORING AND BRACING

- A. The Contractor shall furnish and install all sheeting, shoring and bracing and other protective systems necessary to insure safe working conditions, to prevent subsidence of earth and caving embankments, and to prevent damage to public and private property and structures. The Contractor is responsible for obtaining proper design of such protective systems. The Contractor shall employ an on-site "Competent Person" as defined by OSHA 1926.650 (b), who is responsible for, but not limited to: the locations and

protection of underground installations; recognize and control hazards due to water accumulation; daily inspections of excavations, adjacent areas and protective systems; determine the impact of distress and/or surcharge loads and adjust the protective systems accordingly.

- B. Sheeting, shoring and bracing and other protective systems shall be removed as backfilling progresses, except at such locations as the Engineer may direct or approve it to be left in place.
- C. The condition of all excavations made by the Contractor shall be the responsibility of the Contractor. No extra compensation will be allowed for property damage, injury or loss of time, due to excavation slides or cave-ins at any time under any circumstances.
- D. The Contractor shall cut off any sheeting left in place, at least eighteen (18) inches below finished grade, and shall remove the material cut off without compensation.
- E. Where necessary, in quicksand, soft ground, or for the protection of any structure or property, sheeting shall be driven to such depth below the bottom of the trench as may be required to protect all existing and/or proposed work.
- F. The cost for furnishing, placing and removal of sheeting, shoring or bracing shall be included in the prices bid.
- G. A trench box is an acceptable alternative for pipeline installation to sheeting, shoring or bracing providing such boxes conform, to safety codes and work is monitored by the Contractor's "Competent Person".

3.18 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace material to depth directed by the Engineer; reshape and re-compact at optimum moisture content to the required density.
- C. Settling: Where settling occurs during the Project correction period, remove finished surfacing, backfill with additional approved material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work and eliminate evidence of restoration to the greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off the Owner's property.

3.20 INSTALLATION OF DETECTABLE WARNING TAPE

Pipeline detectable warning tape shall be installed continuously above all underground utilities including but not limited to underground electrical wiring and duct banks, gas, oil, steam, telephone lines and duct banks, water mains, gravity sewer and force mains, chemical feed piping, stormwater mains, or other utility which may be installed or distributed as part of this project. Detectable tape of the color and label required by the particular utility shall be installed in 2 places, 12 inches above the pipe and 12 inches below the ground surface or as recommended by the tape manufacturer. Detectable tape shall be a minimum of 2" wide and be imprinted with the words "Warning! Underground (Utility Type) Below" continuously along the tape. Provide tape colors to utilities as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

END OF SECTION

SECTION 32 12 16

ASPHALT PAVING

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. Cold milling of existing hot-mix asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt paving overlay.
5. Pavement-marking paint.

B. Related Sections:

1. Division 02 Section "Structure Demolition" for demolition, removal, and recycling of existing asphalt pavements, and for geotextiles that are not embedded within courses of asphalt paving.
2. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
3. Division 32 Sections for other paving installed as part of crosswalks in asphalt pavement areas.
4. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants and fillers at paving terminations.

C. Delaware Department of Transportation (DelDOT) Standard Specifications.

D. Delaware Department of Natural Resources and Environmental Control (DNREC) Erosion and Sediment Control Handbook.

1.3 DEFINITION

- A. Hot-Mix Asphalt Paving Terminology: See DelDOT Standard Specifications.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
 - 1. Job-Mix Designs: For each job mix proposed for the Work.
- B. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
- C. Material Certificates: For each paving material, from manufacturer.
- D. Material Test Reports: For each paving material.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by DelDOT.
- B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.
- C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of DelDOT for asphalt paving work.
 - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
- D. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
 - a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
 - b. Review condition of subgrade and preparatory work.
 - c. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
 - d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
- B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: See DelDOT Standard Specifications
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. General: All aggregates for asphalt paving are in accordance with the DelDOT Standard Specifications.

2.2 ASPHALT MATERIALS

- A. All asphalt materials are in accordance with the DelDOT Standard Specifications.
- B.

2.3 AUXILIARY MATERIALS

- A. Paving Geotextile: AASHTO M 288, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.
- B. Joint Sealant: Per the DelDOT Standard Specifications.
- C. Pavement-Marking Paint: As shown on the project plans and in accordance with the DelDOT Standard Specifications.

2.4 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by DelDOT and in accordance with the DelDOT Standard Specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
 2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.
- D. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

3.2 COLD MILLING

- A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
1. Mill to a depth of 2 inches.
 2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
 3. Control rate of milling to prevent tearing of existing asphalt course.
 4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
 5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
 6. Transport milled hot-mix asphalt to asphalt recycling facility.
 7. Keep milled pavement surface free of loose material and dust.

3.3 PATCHING

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
- B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving in accordance with the DelDOT Standard Specifications.
1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- C. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.4 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

- B. Prime Coat: In accordance with the DelDOT Standard Specifications.
- C. Tack Coat: Apply uniformly to surfaces of existing pavement in accordance with the DelDOT Standard Specifications.

3.5 PAVING GEOTEXTILE INSTALLATION

- A. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches and transverse joints 6 inches.
 - 1. Protect paving geotextile from traffic and other damage and place hot-mix asphalt paving overlay the same day.

3.6 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted in accordance with the DelDOT Standard Specifications.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
 - 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.7 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
 - 1. Clean contact surfaces and apply tack coat to joints.
 - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
 - 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
 - 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time.
 - 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 - 6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.8 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers in accordance with the DelDOT Standard Specifications.
- B. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- C. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- D. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.9 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the tolerances found in the DelDOT Standard Specifications.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the tolerances found in the DelDOT Standard Specifications.

3.10 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow paving to age for 14 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
 - 1. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- C. In-Place Density: In accordance with the DelDOT Standard Specifications.

3.12 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an DNREC approved landfill.

END OF SECTION 32 12 16

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SECTION 32 13 13
CONCRETE PAVING

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. Walks.
 - 2. Concrete Pavement
 - 3. Concrete Pads
 - 4. Concrete Curb
- B. Related Sections:
 - 1. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.
 - 2. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.
- C. Delaware Department of Transportation (DelDOT) Standard Specifications.
- D. Delaware Department of Natural Resources and Environmental Control (DNREC) Sediment and Erosion Control Handbook.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

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

- B. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
- C. Other Action Submittals:
 - 1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- D. Material Certificates: For the following, from manufacturer:
 - 1. Cementitious materials.
 - 2. Steel reinforcement and reinforcement accessories.
 - 3. Admixtures.
 - 4. Curing compounds.
 - 5. Applied finish materials.
 - 6. Bonding agent or epoxy adhesive.
 - 7. Joint fillers.
 - 8. Aggregates and sand materials.
- E. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with the DelDOT Standard Specifications.
- B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- C. Pre-installation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to concrete paving, including but not limited to, the following:
 - a. Quality control of concrete materials and concrete paving construction practices.
 - 2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:
 - a. Contractor's superintendent.

- b. Concrete paving subcontractor.

1.6 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces in accordance with the DelDOT Standard Specifications.
- B. Form-Release Agent: In accordance with the DelDOT Standard Specifications

2.2 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from steel wire into flat sheets as shown on the plans and in accordance with the DelDOT Specifications.

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
 - a. Portland Cement: Per the DelDOT Standard Specifications.
- B. Normal-Weight Aggregates: Per the DelDOT Standard Specifications.
- C. Water: Per the DelDOT Standard Specifications.
- D. Air-Entraining Admixture: Per the DelDOT Standard Specifications.

2.4 CURING MATERIALS: All curing shall be in accordance with the DelDOT Standard Specifications.

2.5 RELATED MATERIALS

- A. Joint Fillers: In accordance with the DelDOT Standard Specifications.

2.6 CONCRETE MIXTURES

- A. All concrete shall be Type "B" (3,000 PSI) in accordance with the DelDOT Standard Specifications.

2.7 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete in accordance with the DelDOT Standard Specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
 - 1. Completely proof-roll subbase in one direction. Limit vehicle speed to 3 mph.
 - 2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 - 3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Division 31 Section "Earth Moving."
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

- A. General: In accordance with the DelDOT Standard Specifications.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
 - 1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
 - 2. Provide tie bars at sides of paving strips where indicated.
 - 3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
 - 1. Locate expansion joints at intervals of 50 feet for paving and 20 feet for sidewalks and curbing unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 - 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 - 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 - 6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness at 25-foot intervals for paving and 5-feet for sidewalks.
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes.

3.6 CONCRETE PLACEMENT

- A. Placement of concrete shall be as shown on the plans and in accordance with the DelDOT Standard Specifications.

3.7 FLOAT FINISHING

- A. Float finishing shall be in accordance with the DelDOT Standard Specifications.

3.8 CONCRETE PROTECTION AND CURING

- A. Concrete protection and curing shall be in accordance with the DelDOT Standard Specifications.

3.9 PAVING TOLERANCES

- A. Paving tolerances shall be in accordance with the DelDOT Standard Specifications.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: In accordance with the DelDOT Standard Specifications.
 - 2. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 - 3. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

- a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Concrete paving will be considered defective if it does not pass tests and inspections.
- F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

SECTION_32 1800
SYNTHETIC TURF SHOCK PAD

PART I – GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

- A. General Conditions, Special Conditions and Section “Scope of Work” are part of and govern work under this section.
- B. For construction of the aggregate base layer, see Section 321125, Synthetic TurfSubgrade and Stone Aggregate Drainage Layer.
- C. For synthetic turf carpet, see Section 321820, Synthetic Turf Carpet.

1.2 SCOPE OF WORK

- A. Furnish all labor, materials, tools, and equipment necessary to install, in place, a 19 mm E-layer pad, as indicated on the plans and as specified herein. The installation of all new materials shall be performed in accordance with these specifications, in strict accordance with the manufacturer's written installation instructions, and in accordance with all approved shop drawings.

1.3 SUBMITTALS

- A. Submit with bid:
 - 1. Elastic-Layer Shock Pad - one (1) sample, approximately 100 sq.in. x 19 mm thick.
 - 2. Manufacturer's data offering product technical documentation.
 - 3. Certified list of existing installations.
- B. Prior to order of materials, the Contractor shall submit details on construction, especially any details that may deviate from these plans and specifications.

1.4 QUALITY ASSURANCE

A. Bidder/Manufacturer/Installer's experience:

1. The Bidder/Prime Contractor shall have been actively and directly engaged in constructing stadium athletic fields for a period of five (5) years or more.
2. The Contractor shall employ only qualified, experienced supervisors and technicians skilled in the installation of this system. All E-layer technicians shall be full-time statutory employees of the installer.

1.5 EXISTING CONDITIONS

- A. Contractor will be responsible for any damage to any existing pavement, curbs, utilities, vegetation or structures and shall restore any damage to original or better condition.

1.6 SURFACE AREA

- A. See Site Plans for layout. Contractor to verify all measurements.

1.7 UTILITIES

- A. Owner will supply necessary water, adequate lighting and electricity for installation.

1.8 Warranty

- A. The Shock pad shall be covered by a 25-year limited warranty

PART 2 – PRODUCTS

2.1 MATERIALS

2.1. Synthetic Turf Shock Pad

- A. The approved Shock Pad shall be as follows or approved equivalent

- a. ProPlay-Eco Sport
Schmitz Foam Products
412-575-7993
- b. Brock Power Base
Brock USA
303-544-5800
- c. Ecore BL-41
Ecore
(866) 795-2732

PART 3 - EXECUTION

3.1 GENERAL

- A. All installation operations shall be performed by personnel directly employed by the manufacturer, fully familiar with the materials and their application, under the fulltime direction and supervision of a qualified technical supervisor employed by the installer of the E-layer. Installation supervisors shall have a minimum of five (5) year's experience and job resumes shall be submitted to the Owner with the bid.
- B. The surface to receive the shock pad shall be inspected and certified by the manufacturer as ready for the installation of the system, must be perfectly clean as installation commences, and shall be maintained in that condition throughout the process.
- C. Furnish a written Certification or Letter of Acceptance of the porous aggregate base construction, prior to commencing installation of the E-layer pad.

3.2 INSTALLATION

- A. The aggregate drainage base shall be inspected by the Contractor and checked with a laser level for proper slope and planarity utilizing a minimum of 400 elevation shots; and make corrections as specified herein as required including proper

stability and consolidation. Turf installer shall not approve the aggregate base layer as acceptable for pad placement without reviewing also survey elevations.

- B. The shock pad shall be installed by the manufacturer's personnel per the manufacturer's specification and installation procedures.
- C. Specialized paving equipment shall be operated by a minimum of two skilled technicians at all times. Seams shall be hand rolled and troweled. Cold joints shall be primed with polyurethane primer. Pad thickness shall be continuously monitored for consistency, as well as the mixing ratio. The finished surface shall not vary more than 1/8" in 10 feet as measured in any direction with a 10 foot straight edge.
- D. Testing of the E-layer shock pad, shall be performed as a "system" in conjunction with the synthetic turf, and shall be performed by a recognized sports testing facility.

3.3 CLEAN UP

- A. Contractor shall provide the labor, supplies and equipment as necessary for final cleaning of surfaces and installed items.
- B. The Contractor shall keep the area clean throughout the project and clear of debris.
- C. Surfaces, recesses, tuck slot, etc., shall be cleaned as necessary to leave the work area in a clean, immaculate condition ready for immediate occupancy and use by the synthetic turf Contractor in installing the finished carpet.

-- END --

SECTION_32 1813
SYNTHETIC TURF CARPET

PART I – GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

- A. General Conditions, Special Conditions and Section “Scope of Work” are part of and govern work under this section.
- B. For crushed stone aggregate base layer, see Section 321814, Subgrade and Stone Aggregate Drainage Layer.
- C For new elastomeric layer shock pad, see Section 321800, Shock Pad.

1.2 SCOPE OF WORK

- A. Furnish all labor, materials, tools, and equipment necessary to install, in place, all synthetic turf carpet, as indicated on the plans and as specified herein. The installation of all new materials, including testing, shall be performed in accordance with these specifications, in strict accordance with the manufacturer's written installation instructions, and in accordance with all approved shop drawings.

1.3 SUBMITTALS

- A. Submit with bid:
 - 1. Manufacturer's data offering full product technical documentation.
 - 2. Submit to Owner for approval three (3) copies of quality assurance information as required herein, for initial testing and installation, and for ongoing testing responsibility.

3. Certified list of existing installations, including owner representative and telephone number, attesting compliance with quality assurance information.
4. Laboratory test reports for fabric, backing, ribbon, in accordance with ASTM designated test numbers. Tests shall include, but not be limited to pile height and weight, tuft bind, grab tear strength, backing strength.
5. Laboratory test data for rubber crumb infill.
6. Complete warranty information, including sample warranty.

B. Additional submittals required for this Bid are:

1. Five years of audited financial statements, or as a minimum, five years of financial statements.
2. Litigation in the past five years.
3. Proof that the Turf Manufacturer is a member, in good standing of the Synthetic Turf Council.
4. Projects that have not been completed on time.
5. Principals of the firm with background information.
6. Disclosure of bankruptcies in which any of the principals have been involved in the past ten years.
7. Disputes over warranty claims in the past five years.

C. Prior to order of materials, the Contractor shall submit the following:

1. Field layout indicating striping plans for all specified sports.

2. Seam layout of the field.
 3. Details on construction, especially any details that may deviate from these plans and specifications, including, but not limited to edge details, goal post details, other inserts, covers, etc.
- D. Prior to Final Acceptance, the submit to the Owner three (3) copies of Maintenance Manuals, which will include all necessary instructions for the care and preventative maintenance of the synthetic turf system, including painting and striping.
- E. Prior to the beginning of installation, the manufacturer/installer of the synthetic turf as well as the shock pad subcontractor shall inspect the existing stone aggregate base layer and shock pad, and supply a Certificate of Acceptance for both surfaces for obtaining manufacturer's warranty for the finished synthetic playing surface.

1.4 SHOP DRAWINGS

- A. Shop drawings shall be prepared at the scale of the construction documents and contain all pertinent information regarding installation. These drawings shall be submitted to the Owner for approval prior to the manufacturing and shipment of materials.
- B. Submit drawings for:
1. Seaming plan; seams of pad are not to coincide with seams of synthetic turf nor interfere with subsurface drain system.
 2. Installation details; edge detail, goal post detail, other inserts, etc.
 3. Striping plan; lay-outs for football, soccer, field hockey, men's lacrosse, and women's lacrosse for all fields, showing field lines, markings and boundaries as required by the respective sports sanctioning organization.

1.5 QUALITY ASSURANCE

A. Bidder/Manufacturer/Installer's experience:

1. The Bidder/Prime Contractor shall have been actively and directly engaged in constructing stadium athletic fields for a period of five (5) years or more.
2. The manufacturer and installer shall have been actively and directly engaged in constructing stadium athletic fields for a period of five (5) years or more, and provide proof of ten (10) or more tufted, polyethylene grass-like fabric sports field installations completed by them within the last three (3) years, five of which must be synthetic turf fields in locations and operating conditions similar to those in Delaware.
3. The manufacturer/installer must provide a quality control program, for initial installation and testing, and for ongoing testing regarding responsibility, methodology and protocol. An independent recognized third party testing facility, experienced with synthetic turf, acceptable to the Owner and Architect shall be utilized to test for compliance and acceptance.
4. In addition, the Owner may make such investigations as he deems necessary to determine the ability of the bidder to perform the work, and the bidder shall furnish to the Owner all such information and data for this purpose as the Owner may request. The Owner reserves the right to reject any bid if the evidence submitted by, or investigation of such bidder fails to satisfy the Owner that such bidder is properly qualified to carry out the obligations of the contract and to complete the work specified herein.
5. The Contractor shall employ only qualified, experienced supervisors and technicians skilled in the installation of this system. All turf technicians shall be full-time statutory employees of the turf manufacturer/installer.

Submit resumes of the top two (2) technicians and supervisors with the bid.

B. Prospective bidders must meet the following criteria:

1. Have proper license, in good standing, and have never had a license revoked.
2. Are able to substantiate currently available bonding capacity in excess of \$1,000,000 per project and an aggregate bonding line in excess of \$5,000,000.
3. Have not had a Surety or Bonding company finish work on any contract within the last five (5) years.
4. Have not been disqualified or barred from performing work for any public Owner or other contracting entity.
5. Shall have demonstrated financial strength to fully service and warrant the systems throughout the provision of audited financial statements for the past three years.

B. Warranty: The Manufacturer's Warranty, which guarantees usability and playability of the synthetic turf system shall not be prorated nor limited to the amount of usage. The form of warranty must be furnished and submitted together with the bid for consideration by the Owner and Owner's legal counsel.

1. The warranty submitted must have the following characteristics and must be satisfactory to Owner in all other respects:
 - (a) Must provide full coverage without pro-ration or reduction in amount,
for eight (8) years from the date of Substantial Completion.

- (b) Must warrant materials, workmanship, installation and performance.
- (c) Must warrant that the materials installed meet or exceed product specifications.
- (d) Must have a provision to either repair or replace, without cost to Owner, such portions of the installed materials that are no longer adequate as a serviceable and playable surface. The repair or replacement must provide a serviceable and playable surface comparable to a new surface.
- (e) Must be a warranty from a single source covering workmanship, installation and all self-manufactured or procured materials.
- (f) Guarantee the availability of replacement materials for the synthetic turf system installed for the full warranty period.
- (h) The insured warranty policy must be from an A+ "rated" or better carrier, and must be in force at time of bid, and shall have a minimum of \$1 million dollars per Claim and minimum \$25 million annual policy aggregate.
- (g) The warranty shall be insured by a third party, written to the owner, and be fully pre-paid in advance and be non-pro-rated, and shall have no deductible amounts or self-retention participation

2. Full warranty information regarding the warranty offered and warranty performance of each warrantor shall be provided with the bid, for evaluation by the Owner and Architect.

1.6 EXISTING CONDITIONS

- A. Contractor will be responsible for any damage to any pavement, curbs, fencing, utilities, vegetation or structures during installation of the synthetic turf system, and shall restore any damage to original or better condition.

1.7 SURFACE AREA

- A. See Site Plans for layout. Contractor to verify all measurements.

1.8 UTILITIES

- A. Owner will supply necessary water, adequate lighting and electricity for installation.

PART 2 - PRODUCTS

2.1 MATERIALS – BASIC REQUIREMENTS

- A. Th Synthetic Turf System: A synthetic turf system tufting 10,800 denier monofilament fibers made from a singularly extruded combination of stabilized polyethylene and nylon polymers with proper compatibilizers. Fibers shall be tufted into a suitable primary backing and coated with a secondary metered polyurethane adhesive coating. Pile height shall be nominal 2.5". Fibers shall be tufted to a primary backing and a mechanically applied adhesive secondary backing.
- B. The tufted fiber's face weight shall not weigh less than 52 ounces per square yard. The tufted rows of fiber are to be spaced no more than 1/2" apart. ASTM tests proving the fiber meets these qualifications must be provided with the bid. Turf systems that do not meet this specification will be disqualified.
- C. The carpet's primary backing shall have a minimum weight of 7.0 oz per square yard. The carpet shall then be coated with a secondary backing of polyurethane synthetic coating material with a minimum application rate of 20 ounces per square yard and then perforated for adequate drainage. Carpets that are not perforated for adequate drainage shall not be acceptable.
- D. The carpet shall be delivered in 15' wide rolls. The rolls shall be of

sufficient length to go from sideline to sideline. Head seams, other than at sidelines, will not be acceptable.

- E. The infilled pile surface shall provide good traction in all types of weather with the use of conventional sneaker type shoes, composition molded sole athletic shoes, and screw- in style football cleats.
- F. The pile surface shall be suitable for both temporary and permanent line markings using acrylic paint, as per the turf provider's recommendations.
- G. All adhesives used in bonding the seams shall be resistant to moisture, freeze/thaw, bacteria and fungus attacks, and resistant to ultraviolet radiation. The adhesive shall be made especially for the adhesion of synthetic turf seams and inlaid field markings and graphics.
- H. The seam specific adhesive system shall have been utilized on at least 25 full installations. Provide this information with the bid. It shall consist of a factory-made adhesive bed applied to a non-woven fabric seaming tape. The adhesive bed shall be a metered amount suitable for the application. It shall be heat and pressure activated. A special heat application machine and pressure application using weighted rollers is mandatory.
- I. Supply field groomer and sweeper or single maintenance apparatus that performs both basic maintenance functions.
- J. Perimeter edge details required for the system shall be as detailed and recommended by the turf provider, and as approved by the turf provider.
- K. The carpet shall be anchored to the new track drain and/or concrete curbing, in accordance with the drawings and manufacturer's recommended details, which shall be submitted for approval.
- L. Lines and field markings shall be installed as specified, utilizing manufactured lines at the end of each 15' roll and inlaid lines and markings as specified.
- M. Infill composition shall consist of a ballast layer of silica sand topped by

ambient SBR rubber performance infill in a ratio by weight of 65% rubber / 35% sand. B. Silica sand infill:
Must be clean, sub-angular silica sand
Must be a 20-40 sieve size. C. SBR infill:
Must be ambient SBR Rubber
Must be a 10-20 sieve size.
Immediately after infill layers are installed, infill depth must be measured per testing protocol detailed in Section 1.3 C. 2 above to ensure that infill layer is at least 1.46" deep.

- N. The entire carpet and pad system shall provide a uniform, comfortable and safe playing surface, free from defects and providing consistent footing in all directions. Footing includes wet and dry traction, slip resistance and rotational resistance. The design of the turf fibers shall minimize skin abrasions, and minimize fly-out of rubber crumb infill.
- O. Impact Absorption (force reduction) of the finish field surface and underlying pad shall provide the current industry standard of less than 165 G-max (ASTM F355) over the entire surface, measured at any given test point throughout the entire warranty period. It is understood that G-max values may vary from point-to-point. Initial G-max shall not exceed 110 nor be less than 85 at the time of installation. Submit test results in accordance with Part 4, Post Installation Testing.
- P. Finished field surfaces shall provide adequate stability for athlete body control, and provide consistent and predictable ball performance reaction characteristics.
- Q. The finished field surfaces shall have 15 ft. turf panels, each possessing consistent color and shade, without significantly noticeable streaks, irregularities, or off-color areas, when observed in any direction.

2.2 SYNTHETIC TURF SYSTEM

- A. Provide complete synthetic turf carpet system, as one of the following:

1. Astroturf Rootzone 3D3 Blend 52
 AstroTurf Corporation
 (706) – 277-8873
 2. Spike Zone Pro 2.00
 Shaw Sports Turf
 (866) 703-4004
 3. ULTRABLADE DFE EXTREME 52 with Thatch Zone
 Sprinturf
 (877)686-8873
- B. All materials, installation and warranty shall be in accordance with the latest manufacturer's specification and in accordance with the Contract Documents.

2.3 ATTIC STOCK

- A. Provide a minimum of 750 square feet of synthetic turf carpet for the Owners use for future repairs for each field to be installed.

PART 3 - EXECUTION

3.1 GENERAL

- A. The installation shall be performed in full compliance with approved shop drawings.
- B. Inspect synthetic materials prior to installation for damage or defects, missing goods or insufficient quantities, correct turf pile height, correct backing perforation spacing and diameter, and other materials out-of-tolerance with the specification.
- C. All installation operations shall be performed by personnel directly employed by the

manufacturer, fully familiar with the materials and their application, under the fulltime direction and supervision of a qualified technical supervisor employed by the
turf manufacturer. Installation supervisors shall have a minimum of five (5) year's experience and job resumes shall be submitted to the Owner with the bid.

- D. The surface to receive the synthetic turf shall be inspected and certified by the manufacturer as ready for the installation of the system and must be perfectly clean as installation commences and shall be maintained in that condition throughout the process.
- E. Furnish a written Certification of Acceptance of the porous aggregate base and shock pad construction, as applicable, prior to commencing installation of the turf carpet.

3.2 INSTALLATION – SYNTHETIC TURF CARPET

- A. The stone aggregate base and shock pad shall be inspected by the Contractor and checked with a laser level and string line for slope and planarity, and require corrections as may be required. Turf installer shall not approve the stone aggregate base and the shock pad as acceptable for carpet placement without reviewing and approving the complete installation as specified herein.
- B. Testing prior to shipment shall be performed by random sampling of carpet rolls by the manufacturer, certifying that they meet specifications. Testing shall be for pile composition, pile weight, total height, tuft bind and grab tear strength. Test results shall be conveyed in writing, and provided with the shipment(s).
- C. Synthetic turf shall be installed across the playing field and attached to the perimeter edge detail in accordance with the manufacturer's specification and installation procedures. Turf shall be of sufficient length to permit full cross playing field installation. No head or cross seams will be allowed. The turf carpet system shall be installed to provide stability that will prevent panels from shifting or bunching.

- D. Seams shall be sewn or glued per the manufacturer's specification and installation procedures. Seams shall be flat, tight, and permanent with no separation or fraying. Seam gaps shall be uniform, width not to exceed the gauge of the tufting.
- E. Infill installation is critical to performance and must closely follow manufacturer's recommendations. In addition:
 - 1. Apply when in a dry condition, and when the field is dry.
 - 2. Install uniformly, properly mixed infill and glue materials.
 - 3. Equipment utilized for infill must erect the fiber, place the infill materials, and incorporate a metering method to provide consistent distribution. Equipment shall not distort or displace any base materials, or damage the system.
- F. Fiber conditioning: It is essential to maintain the integrity and uniformity of the fiber throughout the manufacturing, shipping handling, installation and maintenance, in order to prevent damage which could alter performance.

3.3 FIELD LAYOUT AND MARKINGS

- A. The synthetic turf fields will have inlaid football lines, soccer lines, field hockey lines, men's lacrosse lines, and women's lacrosse lines, football numbers and football hash marks, as shown and detailed on the plans and per approved shop drawings; approved by the Owner and the Architect.

3.4 CLEAN UP

- A. Contractor shall provide the labor, supplies and equipment as necessary for final cleaning of surfaces and installed items.
- B. All usable remnants of new material shall become the property of the Owner.
Provide sufficient material for suitable repairs of minor tears, burns, or other minor damage.
- C. The Contractor shall keep the area clean throughout the project and clear of debris.

- D. Surfaces, recesses, enclosures, etc., shall be cleaned as necessary to leave the work area in a clean, immaculate condition ready for immediate occupancy and use by the Owner.

PART 4 – POST INSTALLATION TESTING

4.1. The Contractor shall test for the following:

- (1) After receipt of turf on site – When requested, verify turf identification specification by examination of approximately 2 square feet from two turf rolls taken on delivered material. Examination shall include a DSC (Differential Thermal Scan) for identification of the fiber.
- (2) Perform in-situ testing of the installed turf for Force Reduction.
- (3) When requested, verify the amount of infill: (minimum 3 locations) Vacuum the infill from 1 square foot, dry and sieve and weigh.
- (4) When requested, provide additional performance tests on the completed turf and pad system at 5 locations (UEFA pattern) for Standard Deformation, Ball Rebound, Rotational Resistance (Traction) and Ball Roll. G-max testing is required for all fields, per (2) above.

- 4.2. Tests shall be performed by a professional and experienced testing laboratory specializing in Sports Testing, acceptable to the Owner and the Architect.

- 4.3. Contractor shall provide a quality control, post construction testing program requiring testing at the end of year one, and at the end of year three, and providing the above tests for the Owner's records. Testing thereafter will be at the Owner's discretion, throughout the life of the surface.

PART 5 – MAINTENANCE

- 5.1. Long-term maintenance is necessary for the turf to obtain its maximum useful life. The turf Contractor shall provide detailed written maintenance instructions, suggested guidelines for the system, and training of the Owner's maintenance personnel.

- 5.2. Maintenance consists of but is not limited to cleaning, stain removal, minor seam repairs, dragging or redistribution of any infill material, and management of infill compaction, as well as proper utilization of maintenance equipment.
- 5.3. It will be the Owner's responsibility to maintain a log of field maintenance performed, as recommended and warranted by the turf Contractor.
- 5.4. Periodic cleaning, utilizing sweeping and vacuuming with equipment compatible with field surface will be performed by the Owner per guidelines provided by the turf Contractor.

- - END - -

SECTION 32 1814
SUBGRADE AND STONE AGGREGATE DRAINAGE LAYER

PART 1 - GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

- A. General conditions, special conditions, and Section "Scope of Work" are a part of and govern this section.
- B. Excavation and subgrade compaction, see Section 312000, Earth Moving.
- C. Field perimeter curb, see Section 321313, Concrete Paving.
- D. Field Retaining Walls, see Section 321313, Concrete Paving.
- E. Site storm drainage, see Section 334100, Storm Utility Drainage Piping.
- F. Pre-fabricated Shock Pad, see section 321800, Shock Pads.

1.2 SCOPE OF WORK

- A. Furnish and install a new vertically-drained stone base layer utilizing a stable subgrade, aggregate drainage layer and drainage network.
- B. The design requirements contained in this subsection cover the general minimum considerations in geometric layout and materials. For specific requirements referencing technical testing societies, organizations, associations, etc. see the subsection on Technical Requirements.
- C. The work of this Section includes, but is not necessarily to be limited to:
 - 1. Engineering layout.
 - 2. Erosion and sediment controls.
 - 3. Excavation and grading.
 - 4. Removal of excess earth and topsoil from the site.

5. Construction of a stable subgrade.
6. Construction of the permeable aggregate base layer and underdrain system.
7. Verification of drainage (permeability).
8. Verification of finished surface slope and planarity.
9. Cleanup.
10. Guarantee.
11. Maintenance.

1.3 CONTRACTOR QUALIFICATIONS

- A. The Contractor shall have been actively and directly engaged in constructing stadium athletic fields for a period of five (5) years or more, and provide proof of ten (10) or more sports field installations completed by them within the last three (5) years, five of which must be synthetic turf fields.
- B. In addition, the Owner may make such investigations as he deems necessary to determine the ability of the bidder to perform the work, and the bidder shall furnish to the Owner all such information and data for this purpose as the Owner may request. The Owner reserves the right to reject any bid if the evidence submitted by, or investigation of such bidder fails to satisfy the Owner that such bidder is properly qualified to carry out the obligations of the contract and to complete the work specified herein.

1.4 WORK BY OTHERS

- A. This Contractor shall afford other Contractors reasonable opportunity for the introduction and storage of their materials and equipment and the execution of their work and shall properly connect and coordinate his work with theirs.
- B. Where any part of the Contractor's work depends for proper execution or results upon the work of any other separate Contractor, the Contractor shall inspect and promptly report to the Architect any apparent discrepancies or defects in such work that render it unsuitable for such proper execution and results. Failure of the Contractor to inspect and report shall constitute an acceptance of the other Contractor's work as fit and proper to receive his work, except as to defects which may develop in the other separate Contractor's work after the execution of the Contractor's work.

- C. Should the Contractor cause damage to the work or property of any separate Contractor on the project, the Contractor shall, upon due notice, settle with such other Contractor by agreement or arbitration.

1.5 CONDITIONS

- A. All the conditions, shown and/or specified, and the incidental conditions in or about the project site and structure, shall be considered mandatory parts of the Contract Documents.

1.6 SUBCONTRACTORS

- A. The Contractor shall furnish, within five (5) days after notification, a list of subcontractors he proposes to employ in the work. The approval of subcontractors shall be a condition precedent to award of the contract. All subcontractors shall be subject to the approval of the Architect and/or the Owner.

1.8 MATERIAL SAMPLES AND INSPECTIONS

- A. Submit samples of all dry materials and labels of liquids or wettable powders to be used in construction ten (10) days or more before beginning work.

1.9 ENGINEERING LAYOUT

- A. The Contractor shall employ a registered engineer, landscape architect or surveyor to lay out all lines, grades and construction staking. Periodically throughout this project, the Architect may request the Contractor to verify the required construction elevations.

1.10 SITE PREPARATION - GENERAL

- A. Keep excavation, stored materials, and other areas, free from excess rain or subsurface water at all times.

- B. Excess material excavated, including suitable fill material and topsoil shall be removed.
- C. Any piping, conduits or wiring encountered that are not required to be removed or otherwise encountered shall be temporarily supported and maintained until permanent support has been restored.
- D. Utilize Geotechnical Consultant or Site Engineer for on-site work, inspecting during entire excavation, subgrade stabilization, underdrain system and porous aggregate base layer construction, utilizing a competent Testing Laboratory to evaluate soil conditions and drainage properties. Submit test results, as required, indicating compliance.
- E. Backfill and compact around structures, walls, trenches and where concrete curbs are installed.
- F. Rutting in the subgrade created by offloading and placement of the aggregate material shall be thoroughly repaired, by filling with competent material and compacting and rolling, in accordance with procedures specified herein.
- G. Utilizing laser-guided equipment perform rough and precision grading in areas required, to the lines and grades required for the permeable aggregate base, and in accordance with recommended tolerances.
- H. Keep excavations and the remainder of site free from dirt and debris at all times during the progress of the work, and in accordance with other applicable sections of the specifications.

1.11 CONSTRUCTION OF PERMEABLE AGGREGATE BASE LAYER, AND UNDERDRAIN SYSTEM

A. EXCAVATION

- 1. The site shall be excavated to a depth that the subgrade becomes stable. Topsoil shall be stripped and removed from the site. All other excavated soil shall be removed from the site.

2. When the proper sub-grade elevation is established, the entire area shall be proof-rolled with a ten ton (static weight) smooth-wheeled roller, to delineate localized loose, or soft zones. All such material shall be undercut to competent material.
3. The Site/Geotechnical Engineer will determine whether the materials in the excavated areas are suitable for use as backfill. All unsuitable material shall be removed and all new materials shall be approved before use.
4. The sub-grade shall be constructed using the approved backfill material.

This material shall be placed in lifts not greater than 6" (15.24 cm) in depth. Each lift (layer) shall be compacted separately. The moisture in the soil, at the time of compaction, shall be uniformly distributed and should be within 90 and 120 percent range of the optimum. Within these limits, the Site Engineer will determine the proper moisture level to be used.
5. The backfill material in the first layer shall be rolled until the course has been uniformly compacted to over 95 percent of the maximum dry density. The second and succeeding courses shall be placed and mixed and then compacted as specified in the first course.
6. The finished surface of the sub-grade shall have a finished grade as shown. Sub-grade shall be established to within the tolerance of +0.0' or -0.02' of the design sub-grade elevation.
7. Excavate collector trenches, width and depth as required for the collector drain plus 6 inches on each side of the pipe. Trenches shall be excavated and sloped for drainage. The trenches shall be excavated with the indicated percent slope starting from the high point of the drainage system extending toward the storm drain connection points.
8. All loose debris shall be removed from the tops, edges and inside trenches. The trenches shall then be compacted by tamping or other approved means to 95 percent of the maximum dry density.

B. UNDERDRAIN SYSTEM

1. GEOTEXTILE

Verify that surface elevations of finished sub-grade conform to elevations shown on drawings prior to under drain system construction and that the sub-grade surface is uniform and free of depressions, voids, and irregularities. Provide nonwoven, porous geotextile (DOT Class 1) in accordance with manufacture's written recommendations and DOT Specifications, over the entire field sub-grade. Collector drain trenches shall be lined with non-porous geotextile.

Additionally, overlap joints a minimum of 8". All laps shall be overlapped in the direction the stone aggregate is to be spread. Place a suitable amount of ballast on the fabric to prevent movement by the wind. Ballast shall be in a form which will not damage fabrics. Direct loading on fabric by traffic will not be permitted. Fabric must completely cover perimeter trenches.

2. FIELD COMPOSITE\SECTIONAL TRACK PERIMETER DRAINS

Field Composite Drain - Install perforated under drain conduits at 16 feet on-center as a 45-degree angle on top of the geotextile, securing to fabric every 10-15 linear feet with duct tape, or other suitable material. These conduits shall be a composite drainage system as J-Drain 12 as manufactured by JDR Enterprises, Inc., (800) 843-7569, or acceptable equivalent. Connect ends of these composite drains into the perimeter collector drain pipe, or otherwise direct downward into 50% of the trench depth.

Sectional Track Perimeter Drain - Utilize ACO Sport System #4020 at track perimeter and Sport System #2000 at 'D' Areas, as manufactured by Sports Field Specialties, Delhi, N.Y. 13753, (607) 746-8911; Pro Channel Drain #SE426 at track perimeter and 'XT' slot drain at 'D' Areas as manufactured by Sports Edge, ABT, Inc., Troutman, N.C. (800) 334-6057; or approved equivalent. Drain shall be furnished with eight (8) catch basins with removable trash buckets.

3. COLLECTOR DRAINS

Place perforated under drain pipes in the collector trenches, size per plan. Centerline of the pipe shall coincide with centerline of trench. The pipes shall be capable of withstanding the anticipated loading without deformation. Pipe meeting ASTM standard F-405 (stiffness at 5 percent deflection if 40 psi (2.8 kg/cm²) minimum and the stretch resistance is 10 percent maximum) are suitable for use as under drain. Collector drains must be connected as shown on plans.

- (a) A minimum of 2" of clean, drainable crushed stone aggregate (AASHTO #57) shall be placed in the bottom of the collector trenches, on top of moisture barrier. Compact to 95 percent.
- (b) Place a minimum of 6" of the clean, crushed aggregate on the sides of the under-drain pipes and headers, and 6" minimum of the aggregate on top of the pipe network. Compact suitably.

of

- (c) Prior to placement of the aggregate layer, verify the planarity of the subgrade to tolerance specified, and remove all "lipping" at both sides of all collector drain trenches, to ensure no impediment of surface flow of water into the trenches.

C. AGGREGATE LAYER

- 1. A uniformly mixed aggregate shall be placed over the entire sub-base which has been covered with the geotextile filter fabric. The aggregate shall comprise a minimum of 6" of compacted, stable, permeable crushed limestone aggregate. Care shall be taken to maintain the grade designed for the sub-base. The capability of the aggregate drainage layer to meet the stability and permeability requirement must be determined by a certified laboratory or Contractor prior to construction of the course. It is recommended that the aggregate layer be consolidated to a density of 90 percent. A nuclear density gauge should be used during aggregate placement and rolling to ensure adequate compaction.

2. Submit procedure how contractor proposes to for place, level and consolidate the stone aggregate drainage layer, for Owner and Architect approval.
3. Material shall be a minimum of 75 percent fractured with at least one fractured face by mechanical means on each individual particle larger than 1/4". Material shall be clean of mineral fines.
4. Typical aggregate or aggregate blends found acceptable as an aggregate drainage course conform to the following gradation: (DelDOT NO. 57 Coarse Aggregate may meet the above requirements)

<u>Sieve</u>	<u>Sieve -Metric (mm)</u>	<u>Percent Passing by Weight</u>
1-1/2"	38.1	100
1"	25.4	95 - 100
3/4"	19.0	80 - 100
1/2"	12.7	60 - 80
3/8"	9.52	30 - 50
No. 4	4.75	20 - 40
No. 8	2.38	10 - 30
No. 40	0.42	5 - 17
No. 200	75 mm	1 - 4

D. PLACEMENT OF PERMEABLE AGGREGATE BASE

1. Install permeable aggregate base to the lines and grades indicated.
2. The Contractor shall shape the complete surface of the aggregate base to receive the overlying elastomeric layer pad base and continue until the deviation from the required elevation does not exceed a compensating maximum deviation from grade of 1/8" in 10'.
3. The surface of the aggregate base course shall be well drained at all times. The permeability of the aggregate shall be checked by using 10" diameter cylinder and five (5) gallons of water to drain in less than one (1) minute. Test samples shall be taken (at a minimum of) one sample per every 5,000 square feet or as otherwise directed.

4. All test results will be logged and documented by the Contractor or Site Engineer. If, at any time, the aggregate base does not meet specifications, it shall be the Contractor's responsibility to restore, at his expense, the aggregate base to the required grade, cross section, density and permeability.

5. Moisture Content:

Aggregate must contain 3.5 percent to 4.0 percent moisture content to ensure that fines do not migrate and to facilitate proper compaction. This is critical. Contractor shall ensure that aggregate leaving the source plant meets this requirement and is required to apply water to aggregate on site to attain and maintain this minimum moisture content.

6. Placement:

- (a) Prior to aggregate placement, remove any excess or contaminated backfill from the drainage trenches.
- (b) The sub-grade surface must be free of standing water prior to aggregate placement.
- (c) Ruts in the subgrade created by offloading and placement of the aggregate material shall be thoroughly repaired, by filling with competent material and compacting and rolling, in accordance with procedures specified herein.
- (d) The aggregate should be placed in one lift.
- (e) The aggregate layer must be spread uniformly with equipment that will not cause perceptible separation in gradation (segregation of the aggregates), preferably a self-propelled paving machine.
- (f) Should this occur, during any stage of the spreading or stockpiling (a separation of the materials or particles), the contractor must

immediately remove and dispose of segregated material and correct or change handling procedures to prevent any further separation.

- (g) The Contractor shall utilize dual-plane laser-guided slope and grade equipment control systems for the grading of the permeable aggregate to ensure accuracy in the grade tolerances.

7. Compaction and Planarity:

- (a) The aggregate layer shall be compacted (consolidated) to a minimum density of 90 percent of maximum dry density, utilizing a static, tandem drum-type roller, and as determined by ASTM 0698 and measured using a nuclear method, and to where it is stable.
- (b) Proof roll wherever possible and mark “soft spots” for additional compaction. Use static tandem drum-type roller of not less than five (5) tons weight (non-vibratory roller), to consolidate. Excess rolling will produce segregation of fines and shall be avoided.
- (c) The finished surface shall not deviate (tolerance-to-grade) from designated compacted grade. This means that the surface shall not deviate more than 1/8” in 10’ (any direction) when placed under a 10’ long straight edge. This tolerance is required over the entire field.
- (d) Provide survey elevation of finish graded aggregate base layer specified for verification of field slope and planarity, as specified in Section 02535, 3.2 (A).

Areas that deviate should be marked with spray paint and corrected with material and rolled tight. Such remedial actions should be done by hand.

- 8. Contractor shall provide written certification that the sub-grade and aggregate base has been properly constructed, tested for drainage, slope and planarity, and meet the requirements of the specifications.

-- END --

SECTION 32 18 24

SYNTHETIC RUNNING TRACK SURFACING

PART 1 - GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

- A. General Conditions, Special Conditions and section "Scope of Work" are a part of and govern work under this section.
- B. Paving
 - a. Section 32 1216 – Asphalt Paving
 - b. Section 31 1313 – Concrete Paving
- C. Track perimeter drain
 - a. Section 32 1814 – Subgrade and Stone Aggregate Drainage Layer

1.2 SCOPE

- A. Accept finished bituminous pavement as suitable for these operations. Provide new finished running surface over entire track and field event areas complete with all markings, certifications, testing and warranty. Repair any damage on existing areas or facilities caused by these operations to original or better condition.
- B. Color of synthetic surface shall be red. Overall surface thickness shall not be less than 13 mm.

1.3 STANDARDS

- A. Contractor experience: Contractor shall demonstrate experience in the installation of at least five full sized synthetic polyurethane tracks within the last two years, utilizing the selected surfacing system. Polyresin or water-bound latex systems will not be acceptable. Any contractor wishing to offer an “or equal” must provide a sample, references, installation list and test results from an independent testing lab stating that the proposed product has been tested and

meets the requirements of IAAF performance specifications for synthetic track surfaces.

- B. Manufacturer experience: Documented experience producing polyurethane athletic sports surface, as specified herein.
- C. Quality control: Provide ISO 9001 certification for product design, manufacture and distribution for surfacing product / system utilized.
- D. The primary surfacing materials utilized in the construction shall have proven compatibility and shall be obtained from a single manufacturer
- E. Coordinate installation of synthetic surface with related work in all sections, including placement and acceptance of bituminous pavement.
- F. Quantities of materials: The Contractor will be held accountable for all quantities of material utilized as measured on site, and in accordance with manufacturers printed specifications. Containers shall be labeled, and proof shall be furnished of quantities delivered, stockpiled and utilized.
- G. Utilize only the highest quality materials and precision machinery. Installation and construction shall be first class, utilizing experienced, skilled workmen, installers and supervisors.
- H. Warranty: A written manufacturer's/installer's warranty shall be furnished for all surfacing material for a period of five years from final acceptance for the track and field event surfaces. Warranty shall be against defects in material, workmanship, installation (including adherence to the asphalt), merchandising and fitness. Any defects occurring within the warranty period shall be promptly repaired upon written notification, at no cost to the Owner. Track striping and markings shall be warranted for a period of 2 years.
- I. Certification: All markings shall be certified in writing by qualified personnel that the track has been marked and measured to be in accordance with NFHS requirements. Track and field event surface shall be monitored for performance requirements; established to measure imperfections, surface flatness, surface thickness, force reductions, vertical deformation, friction, tensile properties, color, and drainage characteristics. A letter of certification shall be provided to the Architect that the finished surfaces are furnished and installed in accordance with the manufacturer's printed specification.

- J. Maintenance: The installer shall supply the Owner with written instructions for care of this surface.

PART 2 – PRODUCTS

2.1 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data and installation instructions for track surface material.
- B. Submit (3) samples of track surfacing material. Minimum size 3"x 4".

2.2 TRACK AND FIELD EVENT SURFACE

- A. Synthetic Surface: Provide a black, paved, polyurethane-bound base mat system utilizing SBR rubber with multiple applications of a pigmented (red) structural spray, utilizing EPDM rubber, as Spurtan "BS", in accordance with the manufacturer's latest revised specification, as furnished by Advanced Polymer Technology, Harmony, Pa, (856) 767-3088, or approved equal.

2.2 MATERIALS

- A. Primers: Polyurethane based primers specifically formulated to be compatible with the base and track surfacing material.
- B. Black SBR Granules: The rubber granules for the base mat shall be recycled SBR (styrene Butadiene Rubber) rubber, processed and chopped to 1-3 mm size containing less than 4% dust.
- C. EPDM Granules: The rubber granules for the structural spray wearing coats shall be EPDM peroxide cured, man-made rubber containing a minimum of 20% EPDM and having a specific gravity of 1.5 +/-0.1. The EPDM rubber will be 0.5mm to 1.5mm EPDM granules. EPDM granules shall be the color of the track surface.
- D. Polyurethane Binder: Binder for the black rubber mat shall be an MDI-based mono-component, polyurethane binding agent. The binding agent shall not have a free TDI monomer level above 0.2%, must be clear in color, not milky, and must be solvent free. The binding agent must be specially formulated for compatibility with SBR stranded or rubber crumb.

- E. Structural Spray Coating: The spray coating shall be the MDI-based mono-component, moisture cured, pigmented polyurethane, specifically formulated for compatibility with EPDM granules. The coating shall be red.
- F. Line Marking Paint: The line marking paint shall be polyurethane-based paint specifically manufactured to be compatible with polyurethane synthetic track surfaces.

PART 3 - EXECUTION

3.1 BITUMINOUS SURFACE

- A. Curing: Bituminous paving shall be allowed to cure a minimum of fourteen days prior to track surfacing application. It shall be the responsibility of the surfacing contractor to determine if the paving has cured sufficiently to allow application of the track surfacing.
- B. Bituminous paving shall be verified for pitch and planarity and in accordance with Section ; and flooded with water to check for depressions or low spots, prior to installation of final running surface.

3.2 PREPARATION

- A. The entire area of the new bituminous paving to receive synthetic surface shall be thoroughly cleaned with mechanical air blowers, removing all loose and foreign material. All areas having dirt in the bituminous pores shall be cleaned by means of a high-pressure washer, flushing the surface with clean water. The area shall then be inspected for pitch and planarity in accordance with the requirements of this and the paving section. Areas not found to be in conformance shall be repaired.

3.3 INSTALLATION OF SURFACE

- A. Apply primer and selected surfacing system in strict accordance with manufacturer's printed specification. An additional third spray coat shall be applied to all areas of the field events, as well as the inside two lanes of the track, the start areas for the 200m and 300m intermediate hurdles, and the entire sprint straight (home side). The third spray coat shall be applied at a rate of 1.0 pounds per square yard, in addition to the two coats applied at the standard manufacture's rate of 1.80 pounds per square yard per coat.
- B. Priming: The primer shall be spray-applied in accordance with the manufacturer's specifications. Only those areas which can be installed the same

day should be primed.

C. Mixture Composition: Job mix formulas shall be as follows:

1. Black Mat
SBR Rubber 1-3mm
Binding Agent 20% of total rubber weight
Application Temperature Min. 45 Degrees F.
2. Structural Spray Top Coats 2 or 3 as indicated
Structural Spray 60% by weight
EPDM Rubber 0.5 – 1.5mm 40% by weight
Application Temperature Min. 45 Degrees F.

D. Black Mat: The black rubber granules and polyurethane binding agent are blended together in a suitable mixer for a period of 2 to 3 minutes. The blended materials are then spread onto the asphalt/concrete base by means of a mechanical tandem leveler at a rate of 16 to 16.5 lbs. per square yard. The tandem leveler shall have a heated oscillating screed bar to obtain both smoothness and compaction. The heated screed bar normally works at a temperature of 158 to 176 degrees F.

The layering procedure shall be bay-to-bay and limiting the length of the passes so as not to have any cold (cured) joints between the bays. At the beginning of each day's work, the traverse joint from the previous day shall be tack coated to ensure a good bond. Small irregularities still in the surface after the tandem leveler has passed may be removed using a light polyethylene or teflon roller.

The surface hardens through the reaction of the binding agent with humidity. The speed of the reaction depends on temperature and relative humidity. Usually the surface may be walked upon the next day.

E. Structural Spray Wearing Coats: After the black mat has properly cured, apply a thixotropic mixture, using red Spurtan polyurethane binder and red EPDM granules, mixed in a metal container using a drill and mixing paddle and spray applied with approved air spray equipment designed for this use.

F. Physical Properties (ASTM)	
Thickness:	½" (12-13mm) or as specified
Shore A Hardness (ASTM D-2240):	55 +/- 5
Elongation at break (ASTM D-412):	Approx. 90%
Tensile Strength (ASTM D-412):	0.75 N/mm ² @ 70F
Compression Set Recovery (ASTM D-412):	90% to 95% @ 70F over a 24-hour period
Abrasion Resistance (ASTM D-501):	0.25 grams loss after 1000 cycles
Chalking (ASTM D-822):	No change after 1000 hours in weather meter.
Coefficient of Friction (ASTM D-1984):	Dry: 0.70 to 0.75 Wet: 0.60 to 0.65
Resilience (ASTM D-2632):	37% to 39%
Tear Resistance (ASTM D-624):	50-65 psi

3.4 OFFICIAL TRACK MARKINGS

- A. Contractor shall provide the Owner with a color-coded working drawing showing all necessary track and field event markings. Submit for review and comment prior to any layout or line striping. The track markings shall include all necessary lane lines, start and finish line, relay exchange zones, hurdle markings, lane numbers and all other necessary markings in accordance with NFHS requirements. The paint for all markings shall be an approved polyurethane-based product specifically manufactured to be compatible with the running surface, installed by experienced personnel.

3.5 CERTIFICATIONS

- A. Contractor shall provide the Owner with a document identifying and certifying that all calculations and markings are accurate in accordance with Paragraph 1.3.I. This document shall be field-verified and certified by a registered surveyor or professional engineer experienced in this work.

- - E N D - -

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

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. Chain-link fences and gates.
- 2. Swing Gates
- 3. Ball Safety Netting System.

B. Related Sections:

- 1. Division 03 Section "Cast-in-Place Concrete" for cast-in-place concrete for equipment bases/pads for gate operators and controls and post footings.
- 2. Division 26 Sections for electrical service and connections for motor operators, controls, limit and disconnect switches, and safety features and for system disconnect switches.

1.3 PERFORMANCE REQUIREMENTS

- a. Structural Performance: Chain-link fence and gate framework shall withstand the effects of gravity loads.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.
 - 1. Fence and gate posts, rails, and fittings.
 - 2. Chain-link fabric, reinforcements, and attachments.
 - 3. Gates and hardware.
 - 4. Ball Safe Netting System

- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.

1.5 QUALITY ASSURANCE

- A. Pre-installation Conference: Conduct conference at Project site.
 - 1. Review required testing, inspecting, and certifying procedures.
 - 2. Coordination of new fencing installation and removal of existing fencing.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer/Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:
 - 1. Fabric Height: As indicated on Drawings.
 - 2. Steel Wire Fabric: Wire with a diameter of 0.192 inch (6 gauge).
 - a. Mesh Size: 2 inches.
 - b. Zinc-Coated Fabric: ASTM A 392, Type II, Class 1, 1.2 oz./sq. ft. with zinc coating applied after weaving.
 - c. Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.
 - 3. Selvage: Twisted top and knuckled bottom.

2.2 FENCE FRAMING

- A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:
1. Fence Height: As indicated on Drawings.
 2. Heavy Industrial Strength: Material Group IA, round steel pipe, Schedule 40.
 - a. Line Post: 4.0 inches.
 - b. End, Corner and Pull Post: 4.0 inches.
 3. Horizontal Framework Members: Top and bottom rails complying with ASTM F 1043, 1 5/8 inch diameter.
 4. Brace Rails: Comply with ASTM F 1043, 1 5/8 inch diameter.
 5. Metallic Coating for Steel Framing:
 - a. Type A, consisting of not less than minimum 2.0-oz./sq. ft. average zinc coating per ASTM A 123/A 123M.

2.3 SWING GATES

- A. General: Comply with ASTM F 900 for gate posts and single swing gate types.
1. Gate Leaf Width: As indicated.
 2. Gate Fabric Height: As indicated.
- B. Pipe and Tubing:
1. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing.
 2. Gate Posts: Round tubular steel.
 3. Gate Frames and Bracing: Round tubular steel.
- C. Frame Corner Construction: Welded.
- D. Hardware:
1. Hinges: 180-degree inward swing.
 2. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
 3. Padlock and Chain: Owner will provide locks.
 4. Lock: Closer: Manufacturer's standard.

2.4 FITTINGS

- A. General: Comply with ASTM F 626.
- B. Rail and Brace Ends: For each gate, corner, pull, and end post.
- C. Rail Fittings: Provide the following:
 - 1. Top Rail Sleeves: Round-steel tubing not less than 6 inches long.
 - 2. Rail Clamps: Line and corner boulevard clamps for connecting bottom rails in the fence line-to-line posts.
- D. Tension and Brace Bands: Pressed steel.
- E. Tension Bars: Steel length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
- F. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.
- G. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
 - 1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
 - a. Hot-Dip Galvanized Steel: 0.106-inch; galvanized coating thickness matching coating thickness of chain-link fence fabric.
- H. Finish:
 - 1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. zinc.

2.5 GROUT AND ANCHORING CEMENT

- A. Non-shrink, Nonmetallic Grout: Premixed, factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Erosion-Resistant Anchoring Cement: Factory-packaged, non-shrink, non-staining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

2.6 BALL SAFETY NETTING SYSTEM

- A. Ball safety netting system shall as shown on the project plans and as manufactured by Sportsfield Specialties or approved equal meeting the plan requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
 - 1. Do not begin installation before final grading is completed unless otherwise permitted by Architect/Engineer/Construction Manager.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

- A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.

3.4 CHAIN-LINK FENCE INSTALLATION

- A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
 - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
- C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

- D. Line Posts: Space line posts uniformly at 10 feet o.c.
- E. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
- F. Bottom Rails: Install and secure to posts with fittings.
- G. Chain-Link Fabric: Prior to placing fabric, excavate trench for placement of fence anchoring concrete. Apply fabric to outside of enclosing framework. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released. Pour anchoring concrete as shown on the plans embedding 3-inches of the fabric in the concrete.
- H. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.
- I. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
 - 1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.
- J. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.5 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.6 FIELD QUALITY CONTROL

3.7 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware, gate operator, and other moving parts.

3.8 Ball Safety Netting Installation

A. The ball safety netting system shall be installed per manufacturer's recommendations.

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SECTION 32 80 00
SITE IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Criteria and requirements for the design and construction of an underground, automatically controlled sports field irrigation system including electrical connections, water main connections, and accessories.

B. Related Requirements

1. Earthwork - Trenching, backfill, and compaction for utilities.
2. Water Distribution Systems.
3. Planting.
4. Planting Soils.
5. Erosion Control.

1.2 REFERENCES

A. ASTM International (ASTM)

1. ASTM D2239 - Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Inside Diameter.
2. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series).
3. ASTM D2564 - Solvent Cement for poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
4. ASTM D2609 - Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
5. ASTM D2855 - Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
6. ASTM D3350 - High Density Polyethylene (PE)

B. National Fire Protection Agency (NFPA) 1. NFPA 70 - National Electrical Code (NEC).

C. American Society of Safety Engineers

1. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers.
2. ASSE 1015 - Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies.

1.3 SUBMITTALS

A. Submittal process: Provide all required submittals within 30 days after contract award. Submittals shall be available at all times to the Construction Manager.

B. Quality Assurance Submittals:

1. Irrigation Contractor Qualifications: Provide minimum of 3 references and list of similar projects with owner's names, addresses, and telephone numbers.

C. Test Reports

D. Closeout Submittals:

1. As-Built Drawings:
 - a. Electronic: 2 CD/DVD with PDF and CAD file of irrigation plan.

- b. Hardcopy: Furnish three sets, noting exact locations of elements and changes to Construction Drawings as well as Field notes (as-built completed by the in-field lead irrigator/Irrigation tech).
- 2. Operation Manual:
 - a. Format
 - 1) Electronic: 2 CD/ DVD of manual.
 - 2) Hardcopy: Furnish three copies in a 3 ring binder.
 - b. Manuals shall include the following:
 - c. Approved submittals as specified herein.
 - d. Installation instructions including mounting details for control valves.
 - e. Operating Instructions:
 - 1) Winterization procedures.
Recommended operation sequence, frequency, and length of operation cycle, as per relationship to estimated absorption rate, evaporation rate, plant type and anticipated flow. Provide schedule for winterization procedures.
 - f. Maintenance Instructions:
 - 1) Manufacturers' product data, installation, and maintenance instructions.
Copies of completed warranty information. Contractor to complete and mail necessary warranty registration information to manufacturer keeping copies for Owner.
- 3. Supply friction loss calculations for each zone within system.
- 4. Controller Chart: Prepare color coded chart reduced in size, mounted on the inside of the controller cabinet, containing same plan information as as-built drawings, and laminated in plastic on both sides, with following specific information:
 - a. Note routing of main line, control wires, and controller location.
 - b. Identify valves as to size, station number shown on controller, and type of irrigation head (e.g. micro spray head, rotary head) for each valve with estimated GPM.
 - c. Delineate each station's limits of coverage by color-coding, with each station having different color showing its zone with zone number designation.
 - d. Size, piping type, distance, and location to the distribution water source from POC to isolation valve.
 - e. Size, type, and location of water source.
- 5. Meetings and Inspections Log.

1.4 QUALITY ASSURANCE

- A. Contractor Qualifications: Minimum of 3 consecutive years' experience in area of project and having installed other jobs of similar size and scope.
- B. Pre-Work Meeting and Conference Call: Convene a pre-work meeting and conference call at the Project site prior to commencing subgrade preparation for site paving to review conditions of operations, procedures and coordination with related work. Require attendance of parties directly affecting work of this Section including but not limited to Contractor, irrigation contractor, site work contractor, and Landscape Architect.
 - 1. Discuss conditions of Project site.
 - 2. Review approach and schedule for, but not limited to, the following items:
 - a. Water source.
 - b. Mainline routing and installation.
 - c. Zone installation and site preparation.
 - d. Material availability.
 - e. Sleeve installation, installation of curb and paving markings for sleeve locations and coordination with site work contractor.
 - f. Status of irrigation schedule
 - g. Potential conflicts between irrigation and other site utilities

h. Required Inspections.

Meeting and Inspection Log: Contractor to maintain log of required meetings and inspections. Record the date; time; weather conditions; and a brief summary of the discussions, decisions, and agreements reached. Landscape Architect will review and sign log at the conclusion of the each meeting and inspection. Furnish copy of log to each party attending.

1.5 MEETING AND INSPECTION NOTIFICATIONS

A. Provide the following notifications to the Owner's Civil Engineering Consultant within the time period listed below. Engineer will notify Owner, Landscape Architect, and other necessary sub consultants:

1. Pre-Work Conference Call: Minimum 14 calendar days prior to meeting date.
2. Static Pressure Test: 14 calendar days prior to inspection date.
3. Mainline Inspection and Hydrostatic Test: 7 calendar days prior to beginning irrigation work.
4. Substantial Completion Inspection: 7 calendar days prior to irrigation substantial completion.
5. Final Inspection: 7 calendar days prior to irrigation final inspection date.
6. Warranty Inspection: 14 calendar days prior to inspection date.

B. Provide notifications by email or other written means to show proof of delivery.

1.6 PROJECT CONDITIONS

A. Irrigation contractor to visit site and become familiar with nature and location of work, existing conditions, and conditions that will exist during installation.

1.7 WARRANTY

A. Guarantee Site Irrigation System for a period of 12 months following the Final Inspection approval in accordance with the following:

1. Defects in material, equipment, and workmanship.
2. Repair of damage to premises resulting from leaks or other defects in material, equipment, and workmanship to satisfaction of Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers shall include:

1. Hunter Industries, Inc., (800) 733-2823
2. FEBCO, (800) 767-1234.
3. The Toro Company - Irrigation Division, (888) 384-9939.
4. Site One Landscape Supply, (800) 748-3663

2.2 PIPE

A. Polyvinyl Chloride (PVC): All PVC pipe shall be Schedule 40 or Class 200

- B. Schedule 40 Flexible Polyethylene (PE): Pipe shall conform to ASTM D2239, SDR 11, PE23, rated at 160 PSI, National Sanitation Foundation (NSF) approved. Subject to approval of Owner, PE shall be used for laterals in areas where ground is subject to freezing for extended periods of time each year.

C.

Class 200 Flexible Polyethylene (PE): Pipe shall conform to ASTM D2241, SDR 21, rated at 200 PSI, National Sanitation Foundation (NSF) approved. Subject to approval of Owner, PE shall be used for laterals in areas where ground is subject to freezing for extended periods of time each year.

D. HDPE PE4710 D13.5 Flexible Polyethylene (PE): Pipe shall conform to ASTM D3350, DR 13.5, rated at 160 PSI, National Sanitation Foundation (NSF) approved. Subject to approval of Owner, PE shall be used for main line pipe in areas where ground is subject to freezing for extended periods of time each year.

E. HDPE PE4710 D11 Flexible Polyethylene (PE): Pipe shall conform to ASTM D3350, DR 11, rated at 200 PSI, National Sanitation Foundation (NSF) approved. Subject to approval of Owner, PE shall be used for main line pipe in areas where the main line cross a street and where ground is subject to freezing for extended periods of time each year.

F. Joints:

1. Pipe sizes 3 inch or smaller shall have ball and socket joints. Thrust blocking shall be required in accordance with industry standards.
2. Pipe sizes larger than 3 inch shall have snap connections with rubber gasket joints. Thrust blocking shall be required in accordance with industry standards.

G. Pipe used for reclaimed water shall be appropriate color and marked as designated for such use.

H. Fittings:

1. Polyvinyl Chloride (PVC) Fittings: Fittings shall conform to ASTM D2241, Schedule 40, and Molded.
2. Flexible Polyethylene (PE) Lateral Line Fittings: Fittings shall conform to ASTM D3350, Type 1 PVC insert fittings designed for used with this type of pipe. Pipe and fittings shall be joined with stainless steel pinch clamps or worm gear clamps, including stainless steel screw where pressure levels deem necessary.

I. Risers above finished grade shall be black in color or receive 2 coats of black exterior semi-gloss enamel paint if a color other than black.

2.3 ACCESSORIES

A. Sleeves: Sleeves for pipes passing beneath paving shall conform to ASTM D2241, Schedule 40. Minimum diameter of 2 inch or 2 sizes larger than pipe scheduled to pass through them. B. PVC Solvent Cement: Cement shall conform to ASTM D2564.

C. Swing Joint Connections: Connections between heads and laterals shall be thick wall, flexible, polyethylene pipe, with fittings that have male barbs on one end and either male or female screw ends opposite. Glue fittings and female barb adapters are not allowed.

2.4 RECLAIMED WATER PRODUCTS AND MATERIALS

A. Irrigation products used with reclaimed water shall be the appropriate color and marked as designated for such use.

2.5 CUTOFF OR ISOLATION VALVES

- A. 3 inches or Smaller: Provide full port brass ball valves with 600 WOG rating as manufactured by Red-White Valve Corporation, Carson, CA or equal.
- B. Larger than 3 inches: Provide cast iron and bronze mechanical joint valves, fusion bonded epoxy coated exterior and interior, Resilient Wedge Valve as manufactured by Clow Valve Co., Oskaloosa, IA.
Provide a valve key and cast iron cylindrical valve box with top with each valve.

2.6 QUICK COUPLER VALVES

- A. Provide the following as shown on the plans:
 - 1. Hunter model HQ-44LRC with model HK-44 Key.
- B. Provide each valve with key having 3/4 inch male top pipe threads for hose connection.

2.7 ELECTRIC CONTROL VALVES

- A. Provide the following as shown on the plans:
 - 1. Hunter ICV Series electric remote control valves B.

Provide 3M DBY watertight connectors.

2.8 SPRINKLER HEADS

- A. Full or Part Circle Pop-up Gear Driven Rotor Sprinkler:
 - 1. Acceptable Products:
 - a. Hunter I-25 series pop-up rotors, with check valve.

2.9 DECODERS

- A. Provide the following as shown on the plans:
 - 1. Hunter ICD-100 Single-station decoder with surge suppression and ground wire
 - 2. Hunter IDC -200 2-Station decoder with surge suppression and ground wire
 - a. The minimum recommended level of protection is to have one decoder grounded at the end of each wire path and one decoder grounded every 500 feet.
 - b. Both the controller and the decoders are to be grounded to ground rods or plates with less than 10 ohms resistance.

2.10 VALVE BOX

- A. Valve boxes shall be manufactured by Ametek, Plymouth Products Division, Sheboygan WI., RainBird Corporation or equal by acceptable manufacturer. No irrigation valve box shall be placed in pavement areas or sports field unless otherwise shown on the Drawings.

C.

1. When used with single valve, provide Economy Turf Box or Rain Bird model VB-RND with green colored snap fit cover labeled "Valve Box".
2. When used with 2 or more valves, provide Jumbo Box or Rain Bird model VB-STD with 20 inch x 14 inch cover opening with cover labeled "Control Valve".
3. Support bases of valve boxes with at least 1(one) brick layer to distribute weight over valve box and reduce valve box sinking due to general landscape equipment (I.E ZTR mowers, gators, etc.). If more than one brick layer is required, alternate brick stack pattern.

2.11 MANUAL DRAIN VALVES

- A. Manual drain valves shall be provided by acceptable manufacturers specified above.

2.12 CONTROL WIRE

- A. Number 14-size minimum copper wire, U. L. approved for underground direct burial.

2.13 BACKFLOW PREVENTOR

- A. Comply with requirements and codes of local governing authority regarding backflow prevention.
- B. Provide the necessary materials, insulation/draining capabilities, and insulated hotbox fiberglass enclosure, dark green in color.
- C. Backflow preventers shall be type suitable for use in high hazard cross connection to potable water system as manufactured by one of the following manufacturer's: Watts Regulator Company, Febco, or Wilkins.
 1. Reduced pressure backflow preventers shall be ASSE # 1013 and labeled accordingly.
 2. In absence of local codes or requirements, provide double check assembly backflow preventer installed in strict accordance with manufacturer's written instructions.

2.14 METER

- A. Contractor to provide appropriate meter.
- B. Meter and meter box shall conform to requirements of local utility company.

2.15 RAINFALL / FREEZE SENSOR

- A. Rainfall / Freeze Sensor:
 1. Hunter Wireless Rain/ Freeze Sensor

2.16 FLOW SENSOR

1. Acceptable product:
 - a. Toro TFS Flow Sensor

2.17 MASTER VALVE

1. Acceptable product:

- a. Hunter IBV – to be Commercial Grade, Brass

2.18 AUTOMATIC CONTROLLER

- 1. Acceptable Product:
 - a. Hunter ACC-99D-PED-SS
 - b. Controller shall have an integral weatherproof, lockable stainless steel pedestal cabinet with internal transformer.
 - c. Provide necessary electrical power per local and federal code.
 - d. Mounting controller to surface provided by contractor if applicable.
 - e. Setting the forms, conduit, and cement per manufacturers specs provided by the contractor if applicable.

PART 3 - EXECUTION

3.1 CONSTRUCTION PREPARATION

- A. Pressure/Flow Test: Perform calculations according to the Irrigation Association's 3-Step Method. Provide written calculations to the Owner's Engineer including the following site information:
 - 1. Static or residual pressure at the POC.
 - 2. Calculation of pressure for "worst case" sprinkler head.
 - 3. Calculation of GPM per zone.

- B. Prior to installation, receive approval from General Contractor to proceed with construction.
- C. Contractor shall field verify all aboveground and underground utilities prior to start of work.

3.2 EXCAVATION

- A. Trenching and Backfilling:
 - 1. Trenching and backfilling shall conform to Earthwork Specifications.
 - 2. Excavate trench to proper depth as shown or specified.
 - 3. Minimum trench width shall be 3 1/2 inches.
 - 4. Over excavate trenches deeper than required in soils containing rock or other hard material that might damage pipe and backfill to proper depth with selected fine earth or sand.
 - 5. Backfill and hand tamp over excavation prior to installing piping. No depressions or sunken lines should be evident along trenched paths or swing joints. All grading should be maintained through the warranty.
 - 6. Keep trenches free of obstructions and debris that would damage pipe.
 - 7. Irrigation piping shall not be installed in same trench as heating duct, electric ducts, storm and sanitary sewer lines, water and gas mains.
- B. Do not cut sidewalks, paved areas, or curb and gutter when trenching for piping unless otherwise noted on the Drawings.
 - 1. Provide sleeves as specified in Part 2 above under paving prior to installation of paving.
 - 2. Auger, bore, or tunnel under existing paving without disturbing pavement. Damaged pavement shall be removed and replaced in accordance with Paving Specifications.

3.3 WATER METER

- A. Provide water meter box and meter for irrigation system as shown.

3.4 PIPING INSTALLATION

- A. Minimum cover from top of piping to finished grade shall be provided as follows:
 - 1. Lawn and planting areas:
 - a. Mains and Control Valves: 18 inches.
 - b. Laterals: 12 inches.
 - 2. Drives or parking areas: 24 inches.
- B. Clearances: Maintain 3 inch minimum horizontal clearance between parallel lines in same trench or vertical clearance between lines crossing at angles.
- C. Special Requirements - PVC and PE pipe:
 - 1. Snake pipe in trench at least 1 foot per 100 feet of pipe to allow for thermal expansion.
 - 2. Pipe laterals shall be laid to drain to low point drains located at lowest elevations of each zone.
- D. Rest full length of pipe section on bed of trench, excavating recesses to accommodate joints. Do not lay pipe on unstable material or blocking, or when in opinion of Owner deems the conditions are unsuitable.
- E. Threaded Plastic Pipe Jointing:

1. Do not use solvent cement on threaded joints.
2. Wrap joints with Teflon tape or use virgin Teflon lubricant.

F. Bell and Socket Plastic Pipe Jointing: Cement joints in accordance with ASTM D2855.

3.5 QUICK COUPLER AND AUTOMATIC LOW POINT DRAIN VALVES

- A. Provide quick coupler valves as shown on the drawings to accommodate winterization.
- B. Provide automatic low point drain valves on all zones. Provide two valves at lowest point of each zone with each drain installed above a 12 inch by 12 inch by 12 inch deep area of coarse washed gravel.

3.6 SLEEVING

- A. Provide sleeves for both piping and control wiring where either passes under paved surfaces.
 1. Depths of sleeves shall be same as that required for piping at each location or condition.
 2. Extend sleeves 12 inches beyond paving at each end.
 3. Install permanent benchmark at top of curbs for reference to sleeve locations.
 4. Maximum depth of sleeves will be no more than 24" (inches).

3.7 VALVES

- A. Do not locate beneath paved surfaces.
- B. Install plumb to within 1/16 inch.
- C. Locate within valve box with 6 inch deep layer of coarse gravel beneath bottom of valve.
- D. Install PVC ball valve for plastic valves, or brass gear isolation valves for brass valves immediately before (upstream) all valves and PVC ball valves prior to swing joint, but within valve box of quick couplers matching size of pipe prior to valve or quick coupler
- E. Top of quick coupler valves shall be 6 inches to top of valve box. Top of gravel layer shall be 3 inches below top of valve. Support with 2 (two) metal rods with stainless steel worm gear clamp. Purple valve lid and purple quick coupler cap to be used.
- F. Master Valve:
 1. Locate immediately behind backflow preventer.
 2. Valve shall be energized by master valve circuit on automatic controller.
 3. Provide 6 wires to connection plus two sets of three of which the color must differ from red and white.

3.8 SPRINKLERS

- A. Install plumb to within 1/16 inch with top collar, not nozzle, flush with finish grade.
- B. Provide swing joint with each sprinkler except where entire head is raised above grade and/or where rigid riser piping is required.
- C. Heads adjacent to paving and curb: Locate 6" (inches) from edge of paving or back of curb to prevent car overhang to conflict with a fully extended sprinkler.

3.9 ELECTRICAL CONNECTIONS AND CONTROL WIRE

- A. Conform to the National Electrical Code (NEC) and local electrical codes.
- B. Provide electrical connection to system as designated on the Drawings and as specified herein.
- C. Wire Placement:
 - 1. Do not run control and power supply wiring in same conduit.
 - 2. Provide continuous runs of wire between controller and valves. Splices shall be made with one of following:
 - a. Watertight in ground electrical junction boxes. DBR/Y 600
 - b. Water-tight connectors, such as utilized for valves, and located within valve box for ease of locating.
 - c. The location of electrical splices shall be shown on the As-Built drawings.
 - 3. Bury control wire beside pipe in same trench. Bundle and tape together at not more than 10 ft intervals
- D. Expansion Loops: Construct by wrapping wire around 1/2 inch diameter pipe to create coil. A 3 foot section of wire shall be used to create 12 inch coil with 6 foot section being used to create 24 inch coil.
 - 1. Provide 12 inch coils at each wire splice, not including valves, and at each change of wire direction.
 - 2. Provide 24 inch coils at each control valve, master valve, flow meter and where each valve enters conduit for automatic controller.

3.10 BACKFILLING

- A. Sand or fine-grained soils free of weeds, debris, and rock shall be used for initial backfill to sufficient depth to prevent damage to pipe from rocks or other debris during compaction of subsequent backfill.
- B. Fill trench to within 3 inches of finish grade with excavated soil and compact in accordance with Earthwork Specifications.
- C. Fill top 3 inches with existing topsoil in planting or turf areas and wheel roll until compaction of backfill is same as surrounding soil.
- D. Grade backfilled trench uniform with surrounding grades.

3.11 BACKFLOW PREVENTOR

- A. Comply with local codes for installation of backflow preventer. In absence of local codes, install in accordance with manufacturer's written instructions.

3.12 RAINFALL / FREEZE SENSOR

- A. Location and installation shall be as shown on the Drawings and per manufacturer's written recommendations.

3.13 FLOW SENSOR

- A. Location and installation shall be as shown on the Drawings and per manufacturer's written recommendations.

3.14 MASTER VALVE

- A. Location and installation shall be as shown on the Drawings and per manufacturer's written recommendations.
 - 1. Master valve normal operating position shall be open and shall be electronically actuated.

3.15 AUTOMATIC CONTROLLER

- A. Location and installation shall be as shown on the Drawings and approved by Owner prior to installation.
- B. Install rigid conduits for both power supply and control wiring.
 - 1. Control wire conduit shall extend to 18 inches below grade.
 - 2. Pull spare wires for future valves and extend to area outside paved surfaces.
- C. Install electrical grounding for controller in accordance with manufacturer's written instructions.
- D. All wires (valves and spares) to be labeled within the control box with professional typed lettering labels, numbered and installed in order.

3.16 FIELD QUALITY CONTROL

- A. Irrigation Inspections: Conduct the following inspections during the course of the work in the presence of the Landscape Architect, (each to be notified electronically/over the phone) to verify conformance to specification requirements. Notify Engineer for observation of inspection by the Landscape Architect. Correct noted deficiencies during each inspection prior to proceeding with subsequent work.
 - 1. Mainline/lateral line Inspection: Inspect the installed main line, electronic control valves, Valve box, wiring and wiring splices, quick-coupler valves, isolation valves prior to backfilling.
 - 2. Substantial Completion Inspection: Inspect all completed irrigation work. Landscape Architect will develop a punch list of deficient or incomplete items and deliver to Contractor within 3 calendar days of inspection date.
 - 3. Final Inspection: Within 30 days of project substantial completion date and subsequent to correction of punch list deficiencies, convene a final inspection of all irrigation work.
 - 4. Warranty Inspections: Convene a warranty inspection each 60 calendar days, till expiration of warranty period specified in Landscape Specifications.
- B. Inspection and Adjustments: Following installation and prior to Substantial Completion Inspection, make final adjustments to site irrigation including but not limited to the following:
 - 1. Flush system completely, with nozzles and screens removed and drip lines ends open to extract debris.
 - 2. Verify sprinkler operation (head to head spacing), depth, and alignment for direction of throw. Correct as necessary.
 - 3. Check rotors for proper arc of spray with no overthrow onto pavement. Adjust nozzles as necessary for proper throw and matched precipitation rate.
 - 4. Ensure uniform distribution exists.
 - 5. Ensure proper irrigation head operational after landscaping and/or sod installation.
- C. Main Line and lateral lines Inspection and Hydrostatic Tests:
 - 1. Owner's Landscape Architect, Maintenance personnel and/or Irrigation Designer will observe testing.
 - 2. Center load piping with small amount of backfill to prevent arching or slipping under pressure.
 - 3. Install risers and caps on mainline and sub-main lines. Apply continuous and static water pressure of 120 psi for a minimum of 3 hours when welded plastic joints have cured at least 3 hours.
 - 4. Allowable Leakage:
 - a. Utilize the following formula to calculate the allowable leakage for O-ring gasket pipe. $L=SD(P)^{0.5}$
133,200
In which: L=Allowable leakage in gallons per hour

S=Length of pipe tested in feet

D=Pipe diameter in inches

P=Average test pressure in PSI gauge

- b. No allowable leakage shall be acceptable with solvent based mainline system.
- 5. Repair leaks and retest.

3.17 CLOSEOUT ACTIVITIES.

- A. Demonstration: Following final adjustment, operate entire irrigation installation to demonstrate complete and successful operation of equipment.
- B. Cleanup: Contractor to have all excess materials removed from site and the site in proper order for closeout.

END OF SECTION

SECTION 32 9200
GRASS ATHLETIC FIELD CONSTRUCTION

PART 1- GENERAL

1.1 SECTION INCLUDES

- A. Grass athletic field reconstruction
- B. Root zone preparation for athletic fields.
- C. Seeding and turf grass establishment for athletic fields.
- D. Grow-in maintenance.

1.2 RELATED SECTIONS

- A. Section 31 0000– Earth Moving

1.3 RELATED DOCUMENTS

- A. Erosion and Sediment Control Plan and DNREC requirements for temporary seeding, permanent stabilization, site stabilization during construction as approved DNREC.
- B. Topsoil Test Report.

1.4 DEFINITIONS

- A. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.
- B. Athletic Field:
 - 1. Multi-purpose Field: Playing area as dimensioned on Drawings, including sideline area as extending a minimum of 10-feet from the perimeter of the playing area or to adjacent perimeter fence, not to exceed 25-feet.

2. Baseball and Softball Fields: Playing area as dimensioned on Drawings, including limit of outfield area and extending around entire playing field area to adjacent foul line fence, not to exceed 50-feet.

C. Root Zone: Area of amended topsoil and soil backfill for establishing turf grass

D. Erosion and Sediment Control Plan: Includes all plans, narratives, calculations, and conditions of the as approved and issued by the DNREC. A copy of the approved plans and permit must be available on-site at all times during construction.

1.5 QUALIFICATIONS

- A. Work of this Section shall be performed by a company with a minimum of five years documented experience in athletic field construction with a minimum of 25-acres of documented athletic field construction, turf grass installation, and turf grass maintenance.
- B. Have at least one senior staff member who carries a current "Certified Field Builder – Natural Turf" certification as issued by the American Sports Builders Association.
- C. Contractor shall submit at the time of bid a list and description of a minimum of three projects completed within the last five years of projects of similar scope, including brief description of the work, location, name of owner and contact person.
- D. The Owner reserves the right to evaluate the qualifications of any Contractor or subcontractor and may disqualify any Contractor, or subcontractor, at its sole discretion based on the documented experience of the Contractor.

1.6 STANDARDS

- A. All seed varieties contained in the seed mixtures shall be certified seed by the State where the seed was manufactured.
- B. All chemical applications shall be performed in accordance with local, state, and federal regulations utilizing EPA registered materials and methods of application. All chemical applications shall be performed under the supervision of a Licensed Certified Applicator.
 1. All concentrate materials shall be stored in bulk containers and clearly labeled, including material safety data. No containers shall be stored or left on site.

2. Dispense chemicals from concentrate tanks.
3. Provide spillage containment for concentrates and chemicals.

1.7 SUBMITTALS FOR REVIEW

A. Seeding and Sodding:

1. Manufacturer's Certified Analysis: Submit manufacturer's certified analysis for each seed mix showing percentage of each variety in mix, percent pure live seed, net weight by variety in mix, age of seed, and date of production.
2. Sod Certification: Submit certification from sod supplier indicating State of origin, percentage of grass varieties in sod blend, and State sod certification.
3. Laboratory Test: Submit a minimum of three samples of the existing topsoil, mixed with the organic material and other amendments, consistent with the proportions of the root zone mix to be installed, to approved testing laboratory. Provide Architect with test results prior to installation of root zone mix.
4. Soil Amendments and Turf Establishment Program: Based on the provided Topsoil Test Report, prepare and submit a schedule of soil amendments and fertilization required for each seed mix, time and method of application, a schedule indicating when areas will be seeded, anticipated dates of Substantial Completion, fertilization practices during establishment, application of preemergent and post emergent herbicides, and other practices that will be incorporated as part of the Work. The Architect will consider the submittal for informational purposes only.
5. Product Data: Submit product data, manufacturer's installation instructions, specifications, catalog cuts, and manufacturer's standard shop drawings as required by Section 01330.

1.8 SUBSTITUTIONS

- ##### A. Pre-bid:
- The Contractor shall make every reasonable effort to find the seed varieties and materials specified. Make recommendations for substitutions if desired seed mix

or variety is unavailable, or, in the Contractor's opinion, unsuitable for the site, location to be planted, or other reasons that may result in the failure successfully establish. Notify the Architect if disease resistant or insect resistant species can be substituted for the selected pest-prone species or variety.

- B. Post-Bid: Requests for substitutions following bid shall be approved by the Engineer. Contractor shall submit request in writing, state the reasons for the substitution, and state the variety or mix to be substituted.

1.9 COORDINATION

- A. Coordinate and schedule Work to permit seeding or sodding to occur during regular planting seasons. Where Work cannot occur during regular planting seasons, employ methods as required to address seasonal conditions at time of seeding or sodding.
- B. Coordinate Work under provisions of Section 01310 and so as to avoid conflict with other operations. Contractor shall be responsible for regrading and stabilizing any areas damaged due to a failure to coordinate or schedule construction activities.
- C. Notify Owner a minimum of three days in advance of all maintenance work including regrading, fertilizing and mulching through substantial completion.

1.10 PLANTING SEASONS

- A. Spring: The spring seeding season is March 15 to May 30. Spring seeding shall be conducted during this period unless approved by the Architect to begin seeding earlier or perform summer seeding. No seeding shall be done on frozen ground, when the air temperature is less than 32-degrees fahrenheit, or when the soil temperature is less than 50-degrees Fahrenheit regardless of the date of seeding.
- B. Fall: The fall seeding season is August 31 to October 31. Fall seeding shall be conducted during this period unless approved by the Architect to perform seeding earlier or to perform late fall seeding. . No seeding shall be done on frozen ground, when the air temperature is less than 32-degrees Fahrenheit, or when the soil temperature is less than 50-degrees Fahrenheit regardless of the date of seeding. Permission to seed November 1 to March 14 will only be given when completion of the project is imminent and the environmental conditions are conducive to acceptable growth.

1.11 INSPECTION AND ACCEPTANCE

- A. Minimum area required for inspection and acceptance: Architect will consider requests for inspection to determine Substantial Completion only where the entire athletic field turf has been established. Request for partially completed field areas will only be accepted where Owner schedule has limited completion to a partial area.
- B. Pre-Inspection requirements and certifications: Submit written request to Architect for Substantial Completion inspection. Written request shall include the following:
 - 1. Identification of the field, or field areas to be inspected.
 - 2. Date required Inspection Maintenance would be completed.
 - 3. Performance certifications: Submit following certifications from soil testing laboratory, that the following performance criteria have been met. A minimum of four tests per field is required to determine consistency of the Work:
 - a. Organic matter content must be between 3 – 6 percent.
 - b. Compaction of the field must be no greater than 80-percent as determined by ASTM D1557, Modified Proctor.
 - c. Minimum root depth must be at least 3-inches.
 - d. Organic matter and nutrients must be consistently incorporated to a depth of at least 3-inches.
 - 4. Tolerance of Final Surface for Acceptance: Once fine grading is complete and prior to installation of seed or sod perform a survey of the field. The finished plane of field surface shall not vary by more the 1/4-inch when measured along any point of the plane, whether perpendicular or parallel to the contour. Finished slope shall be within one tenth of a percent (0.10%) of the design gradient.
 - a. Survey Certification: Submit a plan, prepared and sealed by a registered professional surveyor, with spot elevations on a grid interval of twenty-five feet. Grid shall tie to a minimum of two field corners and shall be based on project datum. Plan shall be considered for verification of finished field grade tolerance.
- C. Inspection: Upon completion of the Work as defined in Paragraph 1.13.A, request an inspection to determine substantial completion. Request shall be made to the Architect in writing and Architect shall complete inspection within two weeks of receipt of request for inspection. Contractor shall clearly note in request for inspection which areas are substantially complete if not requesting inspection for the entire installation.

1. Architect will issue a notice of Substantial Completion following inspection where Work is substantially in conformance with the specified requirements and Drawings. Minor deficiencies shall be noted and Contractor shall correct all deficiencies within two-weeks of receiving notice.
 2. Where Architect determines that Work is not substantially complete due to significant deficiencies, Contractor shall take immediate corrective action. Upon completion of corrective measures, Contractor shall again request inspection to determine if Substantial Completion has been obtained.
- D. Inspection Maintenance: Grass shall be cut to specified height, including hand trimming, turf area substantially free of weed growth and perimeter of infield areas and along walkways edged a maximum of three days prior to requesting inspection for Substantial Completion.

1.13 WARRANTY

- A. For athletic fields that do not include installation of subsurface irrigation systems the warranty for the turf areas shall be forty-five (45) days from the date of completion of the Substantial Completion punch list and written acceptance of the field by the Owner. Rebuild, repair, or replace any areas of turf that have proven defective due to failure to comply with the Specifications in any way.
1. Contractor is not responsible for defective areas due to vandalism, areas that have been damaged by the Owner or Owner's use, or as a result of the Owner's failure to execute maintenance procedures following substantial completion.

1.14 GROW-IN PERIOD MAINTENANCE SERVICE

- A. Maintain seeded and sodded areas immediately after placement until grass is well established. Maintain all seeded areas until a vigorous, weed free, healthy growing condition is present and Substantial Completion is established.
1. Seeded Areas: A request for inspection to determine Substantial Completion will not be considered until a vigorous uniform growth over at least 90% of the seeded area is present.
 2. Sodded Areas: A request for inspection to determine substantial completion will not be considered until the sodded area has been in place for a minimum of 45 calendar days and sod exhibits a vigorous growing condition.

- B. Where seeding or sodding is required outside of the Spring or Fall Planting seasons, perform additional maintenance, provide additional mulch, frost protection blanket, compost, increased seeding rate, over-seeding, and other Work as required to improve germination conditions.

PART 2 - PRODUCTS

2.1 TOPSOIL INSTALLATION AND GRADING EQUIPMENT

- A. General: All equipment operation in the root zone area shall be rubber floatation turf tires or rubber tracks.
- B. Deep-Tine Aeration: Turf grass aeration machine having 3/4-inch solid tines capable of penetration a minimum of twelve-inches with hole spacing no greater than 5-inches. Unit shall be PTO driven with a rear roller on unit. Tractor shall have a minimum horsepower rating of 55, turf tires, and a lift capacity of 3,600 pounds.
- C. Soil Screener: Portable “star” type screener capable of screening a minimum of 1,500 cubic yards of dry soil per day
- D. Rough Grading and Finished Grading: Grader equipped with dual laser pickup with dual laser grade range mode. The laser pickup shall operate the blade elevation controls automatically once locked on the laser beam. Laser source shall be capable of operating in either the positive or negative angle configuration without physically moving the laser source head.
 - 1. Laser source accuracy: One thousandth of a percent (0.000).
 - 2. Grader shall have rubber flotation turf tires.
- E. Tilling: Reverse-sifting tiller, Roto-dairon or equivalent, operating at a minimum of 110 horsepower and capable of ground speeds of 1/3 mph.

2.2 TOPSOIL

- A. On-site available topsoil or approved imported topsoil. The Contractor shall be responsible for providing satisfactory topsoil as required to meet the quantities necessary for the Work.

- B. Soil Testing: Soil tests shall be done prior to seeding by Contractor. The soil test shall include a mechanical analysis to determine soil texture, pH, magnesium, phosphorus, and potassium. Testing shall also measure organic matter and soluble salts. The minimum number of soil tests shall be six spaced randomly throughout the field to obtain the most thorough sampling. Topsoil shall not be tested until it has been stripped and stockpiled. All imported topsoil shall be approved by the Architect before the material is delivered to the site.
- C. Soil Amendments: Amend topsoil as determined by the soil tests to adjust soil conditions to obtain required organic matter content, soil reaction, and nutrient availability in the root zone.
 - 1. The presence of conditions affecting fertility, germination, high or low organic content, soil compaction, or similar conditions does not alleviate the Contractor of responsibility to provide required growing and germination conditions.
- D. All topsoil shall be free of stones, lumps, plants, roots, and other debris over 3/4inch at time of initial placement on finished subgrade. Topsoil shall be free of weeds, weed seeds, foreign grasses, and toxic substances, such as pesticides, that are harmful to plant growth.

2.3 FERTILIZER

- A. All fertilizer shall be uniform in composition, free flowing and suitable for application by mechanical spreaders. Fertilizers shall be delivered in sealed containers showing percentage by weight of all components and shall bear the name, trade name, and warranty of the producer.
 - 1. Application rate: Per soil test.
- B. Starter Fertilizer: Ratio of 1-2-1, consisting of 50% Nutralene. Apply at a rate of 1 lb. Nitrogen/1,000 square feet

2.4 LIME

- A. Lime material shall be ground or pulverized limestone that contains at least 50percent total oxides, calcium oxide plus magnesium oxide. Limestone shall be ground to such fineness that at least 50-percent will pass through a 100-mesh sieve and not less than 98-percent will pass through a 20-mesh sieve. Granular or pelletized lime may also be used subject to the requirements for pulverized limestone.

1. Application rate: Per soil test.

2.6 ORGANIC MATTER

- A. Commercially available uniform compostion meeting the following:

PH:	6.5 – 8.5
Moisture Content:	30% - 55%
Soluble Salts:	<4.0 mmhos/(cm)
C:N Ratio:	25:1
Particle Size:	<3/8"
Organic Matter Content:	>40% (dry weight basis)
Ash Content	<60%
Nitrogen	0.5% to 3%
Phosphorous	>0.2%

(Equal to Terra-Gro, Terre Hill, PA 17581. Phone number 1-800-359-1384.)

- B. Other equal naturally occurring organic product blended for turf grass use.

2.7 HYDROMULCH

- A. Mulch: Mulch shall be wood cellulose fiber, containing no growth or germination inhibiting substances; a soil-binding agent (tackifier) is required; mulch shall be dyed a suitable color to facilitate placement. Features also defined in Section 2.10B below.
- B. Liquid Mulch Binder: Non-asphaltic or petroleum based, Reinco, RMB plus (1800-526-7687), Finn A 500 Hydro-Stik (1-800-873-3321), or equal capable of controlling wind and water erosion of mulch.

2.8 SEED MIX

- A. Seed Mixture: 100% Turf Type Tall Fescue with any three of the following varieties: Hemi, Turbo, Bullseye, Rebel Exeda, Summer, No Net
 1. Seed shall be a minimum of 80-percent endophyte enhanced, consist of a minimum of 98-percent pure seed with 0-percent weed seed, and have a minimum 90-percent germination rate.
 2. Seeding Rate: Turf Type Tall Fescue – 11 pounds per 1,000 SF

- B. Apply all seed mixtures at half-rates in two cross-directions.

2.9 MULCHING MATERIALS

- A. Salt Hay: Free of rot, mildew, noxious weed seeds and shall be small-grained, such as wheat or barley. Apply at a rate to lightly cover soil, approximately 100 lbs. per 1,000 square feet.
- B. Cellulose Fiber: Specially prepared cellulose processed into a uniform fibrous physical state. The fiber mulch, including dye, shall not contain germination or growth inhibiting factors. The material shall be manufactured and processed in such a manner that the cellulose fiber mulch will remain uniform in suspension in water under agitation and will blend with seed, fertilizer, and other additives to form homogenous slurry. The mulch shall cover and hold grass seed in contact with the soil without inhibiting growth of the seedlings. Contractor may utilize other mulches, such as recycle paper and wood blend, recycled paper, and companion binding accessories at his discretion in hydro-seeding. The rate of cellulose fiber shall be 50 pounds per 100 gallons of water or as otherwise recommended by the County Agriculture Cooperative Extension

2.10 MULCH ANCHORING MATERIALS

- A. Mechanical Method: Tractor-drawn implement designed to punch and anchor mulch into the soil surface.
- B. Cellulose Fiber: Cellulose fiber shall be applied at a net dry weight of 750 pounds per acre.
- C. Liquid Mulch Binder: Non-asphaltic or petroleum based, Reinco, RMB plus (1-800526-7687), Finn A 500 Hydro-Stik (1-800-873-3321), or equal capable of controlling wind and water erosion of mulch.
- D. Mulch Netting: Prefabricated wood shaving mat with woven photodegradable netting.

2.11 EROSION CONTROL FABRIC

- A. As specified on the Drawings.

2.12 WATER

- A. Clean, potable, free of chemicals or impurities harmful to germination or turf growth.
- B. Public water, Owner supplied following installation of site water service. If either the pressure or supply of public water is insufficient to properly irrigate the athletic fields, alternative methods such as tankers and pumps can be considered upon review and approval by the Owner.
- C. For grow in maintenance on a field that does not have a permanent subsurface irrigation system a temporary above ground irrigation system is to be used consisting of series of pipes and sprinkler heads connected to the Owner's water supply. System shall be used until field is ready for inspection.

2.13 HERBICIDE

- A. Broadleaf: depending upon weeds being encountered and Owner's preference of use.
- B. Pre-emergent: Tupersan, or approved equal. This is to be used on both seeded and sod fields.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification:
 - 1. Verify that topsoil has been placed to the minimum depths required. Verify that topsoil has been screened and all rocks and debris greater than 3/4-inch removed from the topsoil area that will comprise the root zone.
 - 2. Verify that all products for installation are undamaged and are correct Models specified. Reject damaged or incorrect products.
- B. Do not sow seed or initiate seeding operations when ground is wet or muddy following a rain event, when the ground surface is excessively dry and dusty, or when wind velocity will result in an uneven distribution of seed.

3.2 ROOT ZONE PREPARATION – NEW FIELDS

- A. Scarify the subsoil and remove stones and debris larger than 6"
- B. Spread the topsoil with a LGP laser controlled dozer
- C. Decompact the field to a minimum depth of 12": two times over in a crossing pattern. Use a shatter harrow or subsoiler. Rubber floatation tired tractors only to be used.
- D. Rough grade the field to within +/- 1" of finished grade. Rubber floatation tired tractors only to be used
- A. Incorporate organic matter and other nutrients into root zone after topsoil is rough graded to achieve desired percentages and nutrient levels. Incorporate into the soil with a Lely Roterra or reverse tine tiller. Organic matter shall be incorporated in the topsoil at a consistent depth of three-inches over the athletic field area. Rubber floatation tired tractors only to be used.
- B. Fine grade field to required grade, plane, and elevation as indicated on Drawings. Use rubber floatation tired laser guided grader.

3.3 SEEDING

- A. Perform required as-built survey of the field to confirm work meets finished field grade tolerance. Any areas not found in compliance shall be repaired to meet required tolerances.
- B. Perform seeding operations within 24-hours of completing fine grading operations including repairs if necessary.
- C. Sow seed at the rates specified in one-half rates evenly in two intersecting directions using a broadcast, drop-type spreader or cultipacker. Roll surface to establish seed contact with soil using a smooth drum roller weighing no more than one ton.
- D. Manually sow seed where areas are not accessible to mechanized seeding equipment. Seed shall be evenly distributed and rake in to the top 1/4-inch of the soil.
- E. After seeding, apply starter fertilizer.
- F. Mulching: Apply mulching material to retain moisture and minimize erosion. Apply straw mulch as required by the Erosion and Sediment Control Plan. Anchor mulch to prevent displacement by tracking in or using commercial tackifier.

- G. Apply water with a fine spray after each seeded area has been mulched. Water sufficiently to saturate upper three – four inches of root zone.
- H. Place signs, rope off, or otherwise protect newly seeded areas from encroachment. Maintain protection until seeded areas are accepted by Owner.

3.4 EROSION CONTROL

A. Temporary Seeding

- 1. Perform temporary seeding and mulching work when required to stabilize construction areas in accordance with the requirements of the Erosion and Sediment Control Plan.
- 2. Prior to final seeding, any temporarily seeded area shall have the existing stand of turf completely killed to prevent invasive growth of the temporary seed variety in the final seeding.

B. Reseeding and Overseeding

- 1. During grow-in period, immediately repair areas that have washed or become eroded and perform additional measures as required to stabilize. When directed by Architect, as authorized by a Change Order, sod may be installed at areas where stabilization is difficult.
- 2. Where areas have failed to germinate, mechanically reseed.

3.5 GROW – IN MAINTENANCE SERVICE

- A. Scheduling: Perform all maintenance until the required growing condition is present and Substantial Completion has been established. Notify Owner a minimum of three days in advance prior to performing any maintenance operation.
- B. Apply 3-1-2 fertilizer at a rate of 1 lb. Of Nitrogen per thousand square feet.
- C. General Procedures:
 - 1. Edging: Edge along perimeter of all sidewalks, paved areas, landscape beds, infield areas, and slabs a maximum of three days prior to request for Substantial Completion inspection.

2. Mowing: Cool season grasses, including bluegrass, tall fescue, and perennial ryegrass shall be maintained at a height of 2-1/2- inches to 3-1/2inches in the spring and fall. During the summer, the mowing height shall not be less than three-inches. No more than 1/3 of the blade shall be removed in a single cutting.
 - a. Perform a minimum of one mowing a minimum of three days prior to requesting an inspection for Substantial Completion for any turf area included in the request for Substantial Completion inspection.
 - b. During the period from initial seeding / sodding through Substantial Completion, mow, when the average height of the grass three-inches.
3. Fertilizing: Fertilize seeded areas as required until Substantial Completion is established. Base fertilization on the requirements of the turf species, time of year, and soil test results. Obtaining additional soil test results when required for fertilization between initial seeding and establishment of Substantial Completion.
4. Lawn/Weed Control: Apply a pre-emergent soil applied herbicide for all spring and summer seedings to control the germination of crabgrass and other annual weed seeds. Prior to a request for Substantial Completion inspection, a post emergent, foliar applied, herbicide shall be applied to prevent the growth of broadleaf weeds in mid to late May to control summer weeds and in late September or early October to control fall weeds. Selection and proper use of herbicides is the Contractor's responsibility. All chemical applications shall be performed under the supervision of a licensed certified applicator.
5. Insect and Disease Control: Monitoring all newly established lawn areas for insect damage and disease and taking any corrective measures as required. The Contractor shall only be responsible for disease and insect control until Substantial Completion is established.
6. Irrigation: Maintain sufficient moisture in the soil during germination and as required for turf establishment until Substantial Completion.
7. Repair: Repair all areas that have washed or eroded, correct surface irregularities for areas that have settled and pond water, and remedy damage from improper use of herbicides or over fertilization.

NEW CASTLE COUNTY VOCATIONAL -
TECHNICAL SCHOOL DISTRICT

PAUL M. HODGSON VOCATIONAL
TECHNICAL HIGH SCHOOL

--END --

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

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. Chain-link fences and gates.
- 2. Swing Gates
- 3. Ball Safety Netting System.

B. Related Sections:

- 1. Division 03 Section "Cast-in-Place Concrete" for cast-in-place concrete for equipment bases/pads for gate operators and controls and post footings.
- 2. Division 26 Sections for electrical service and connections for motor operators, controls, limit and disconnect switches, and safety features and for system disconnect switches.

1.3 PERFORMANCE REQUIREMENTS

- a. Structural Performance: Chain-link fence and gate framework shall withstand the effects of gravity loads.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.
 - 1. Fence and gate posts, rails, and fittings.
 - 2. Chain-link fabric, reinforcements, and attachments.
 - 3. Gates and hardware.
 - 4. Ball Safe Netting System

- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.

1.5 QUALITY ASSURANCE

- A. Pre-installation Conference: Conduct conference at Project site.
 - 1. Review required testing, inspecting, and certifying procedures.
 - 2. Coordination of new fencing installation and removal of existing fencing.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer/Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:
 - 1. Fabric Height: As indicated on Drawings.
 - 2. Steel Wire Fabric: Wire with a diameter of 0.192 inch (6 gauge).
 - a. Mesh Size: 2 inches.
 - b. Zinc-Coated Fabric: ASTM A 392, Type II, Class 1, 1.2 oz./sq. ft. with zinc coating applied after weaving.
 - c. Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.
 - 3. Selvage: Twisted top and knuckled bottom.

2.2 FENCE FRAMING

- A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:
1. Fence Height: As indicated on Drawings.
 2. Heavy Industrial Strength: Material Group IA, round steel pipe, Schedule 40.
 - a. Line Post: 4.0 inches.
 - b. End, Corner and Pull Post: 4.0 inches.
 3. Horizontal Framework Members: Top and bottom rails complying with ASTM F 1043, 1 5/8 inch diameter.
 4. Brace Rails: Comply with ASTM F 1043, 1 5/8 inch diameter.
 5. Metallic Coating for Steel Framing:
 - a. Type A, consisting of not less than minimum 2.0-oz./sq. ft. average zinc coating per ASTM A 123/A 123M.

2.3 SWING GATES

- A. General: Comply with ASTM F 900 for gate posts and single swing gate types.
1. Gate Leaf Width: As indicated.
 2. Gate Fabric Height: As indicated.
- B. Pipe and Tubing:
1. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing.
 2. Gate Posts: Round tubular steel.
 3. Gate Frames and Bracing: Round tubular steel.
- C. Frame Corner Construction: Welded.
- D. Hardware:
1. Hinges: 180-degree inward swing.
 2. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
 3. Padlock and Chain: Owner will provide locks.
 4. Lock: Closer: Manufacturer's standard.

2.4 FITTINGS

- A. General: Comply with ASTM F 626.
- B. Rail and Brace Ends: For each gate, corner, pull, and end post.
- C. Rail Fittings: Provide the following:
 - 1. Top Rail Sleeves: Round-steel tubing not less than 6 inches long.
 - 2. Rail Clamps: Line and corner boulevard clamps for connecting bottom rails in the fence line-to-line posts.
- D. Tension and Brace Bands: Pressed steel.
- E. Tension Bars: Steel length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
- F. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.
- G. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
 - 1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
 - a. Hot-Dip Galvanized Steel: 0.106-inch; galvanized coating thickness matching coating thickness of chain-link fence fabric.
- H. Finish:
 - 1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. zinc.

2.5 GROUT AND ANCHORING CEMENT

- A. Non-shrink, Nonmetallic Grout: Premixed, factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Erosion-Resistant Anchoring Cement: Factory-packaged, non-shrink, non-staining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

2.6 BALL SAFETY NETTING SYSTEM

- A. Ball safety netting system shall as shown on the project plans and as manufactured by Sportsfield Specialties or approved equal meeting the plan requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
 - 1. Do not begin installation before final grading is completed unless otherwise permitted by Architect/Engineer/Construction Manager.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

- A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.

3.4 CHAIN-LINK FENCE INSTALLATION

- A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
 - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
- C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

- D. Line Posts: Space line posts uniformly at 10 feet o.c.
- E. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
- F. Bottom Rails: Install and secure to posts with fittings.
- G. Chain-Link Fabric: Prior to placing fabric, excavate trench for placement of fence anchoring concrete. Apply fabric to outside of enclosing framework. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released. Pour anchoring concrete as shown on the plans embedding 3-inches of the fabric in the concrete.
- H. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.
- I. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
 - 1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.
- J. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.5 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.6 FIELD QUALITY CONTROL

3.7 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

- A. The ball safety netting system shall be installed per manufacturer's recommendations.

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SECTION 33 41 00

STORM UTILITY DRAINAGE PIPING

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. Pipe and fittings.
2. Nonpressure transition couplings.
3. Pressure pipe couplings.
4. Expansion joints and deflection fittings.
5. Drains.
6. Encasement for piping.
7. Manholes.
8. Channel drainage systems.
9. Catch basins.
10. Stormwater inlets.
11. Stormwater detention structures.
12. Pipe outlets.
13. Stormwater disposal systems.
14. Stormwater Management Facilities
15. Sectional Track Perimeter Drain
16. Infield Edge Drains
17. Turf Field Underdrains

- B. Delaware Department of Transportation (DelDOT) Standard Specifications.
- C. Delaware Department of Natural Resources and Environmental Control (DNREC) Sediment and Erosion Control Handbook.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. Catch basins: Include plans, elevations, sections, details, frames, covers, and grates.
3. Piping: Include manufacturer's certification for each pipe type.
4. Stormwater Management Facility Outlet Structures.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.
- D. Handle catch basins according to manufacturer's written rigging instructions.

1.5 PROJECT CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 1. Notify Architect/Engineer, Construction Manager and Owner no fewer than two days in advance of proposed interruption of service.

PART 2 - PRODUCTS

2.1 PIPING

- A. All storm drainage piping shall be as shown on the plans and in accordance with the DelDOT Standard Specifications.

2.2 MANHOLES

- A. All storm water manholes shall be as shown on the plans and in accordance with the DelDOT Standard Specifications.

2.3 CATCH BASINS

- A. All catch basins shall be as shown on the plans and in accordance with the DelDOT Standard specifications.

2.4 STORMWATER MANAGEMENT STRUCTURES

- A. All structures shall be as shown on the plans and in accordance with either the DelDOT Standard Specifications or the DNREC Erosion and Sediment Control Handbook.

2.5 SECTIONAL TRACK PERIMETER DRAIN

- A. Utilize ACO Sport System #4020 at track perimeter and Sport System #2000 at 'D' Areas, as manufactured by Sports Field Specialties, Delhi, N.Y. 13753, (607) 746-8911; Pro Channel Drain #SE426 at track perimeter and 'XT' slot drain at 'D' Areas as manufactured by Sports Edge, ABT, Inc., Troutman, N.C. (800) 334-6057; or approved equivalent. Drain shall be furnished with eight (8) catch basins with removable trash buckets.
- B. Drain shall be connected at the 8 catch basin locations to the field's collector drainage system, as shown on plans and detailed.
- C. Provide manufacturer's descriptive information for these products for approval as well installation instructions and procedures.

2.6 "HYDROBLOX" INFIELD EDGE DRAINS

- A. Hydroblox is a prefabricated thermoplastic non-clogging drainage plank approximately 2"x 9"x 40" long, installed in a single line a 4-5" wide trench that is cut with hand trenching equipment.
- B. Provide the hydroblox where shown and detailed at the circular edge of skinned infields starting at the center of the skinned area, and sloping at no less than 0.50% toward either side of the infield to discharge points a shown on plans. The initial high point of the trench should be cut to a level that the top of the hydroblox plank is positioned at or slightly below the level of the subgrade at the circular edge of the infield.
- C. Upon completion of trenching and installation of the Hydroblox, backfill and clean excess soil from trenches, ready for seeding.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, non-pressure drainage piping according to DelDOT Standard Specifications.

3.4 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated in accordance with the DelDOT Standard Specifications.

3.5 CATCH BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated in accordance with the DelDOT Standard Specifications.

3.6 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 - 1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads.
- B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:
 - 1. Remove manhole or structure and close open ends of remaining piping.

- C. Backfill to grade according to Division 31 Section "Earth Moving."

3.7 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

3.8 CLEANING

- A. Clean interior of piping of dirt and superfluous materials.

END OF SECTION 33 41 00