PROJECT MANUAL

FOR

CAPE HENLOPEN SCHOOL DISTRICT

CAPE HENLOPEN HIGH SCHOOL ADDITIONS

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ABHA PROJECT NUMBER: 1812

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CD REVIEW
VOLUME 4 OF 4
DIVISION 26 - 33

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SECTION 260500 - 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, "Alternates" for description of work under this Division affected by Alternates.

1.3. SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Foam duct sealant.
4. Grout.
5. Plywood backboards.
6. Protective wire guards.
7. 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.

E. 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.

F. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.

G. Coordinate the work under Division 26 with the work of all other construction trades.

H. 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.

1.4. CONTRACTOR QUALIFICATION

A. Any Contractor or Subcontractor performing work under Division 26 shall be fully qualified and acceptable to the Architect/Engineer and Owner. Submit the following evidence when requested:

1. A list of not less than five comparable projects which the Contractor completed.

2. Letter of reference from not less than three registered professional engineers, general contractors or building owners.

3. Local and/or State License, where required.

4. Membership in trade or professional organizations where required.

5. Copy of Master Electrician's License.

B. A Contractor is any individual, partnership, or corporation, performing work by contract or subcontract on this project.

C. Acceptance of a Contractor or Subcontractor will not relieve the Contractor or subcontractor of any contractual requirements or his responsibility to supervise and coordinate the work, of various trades.

D. Supervisory Qualifications: The electrical work on the project shall be under the direct supervision of a licensed Master Electrician.

E. Qualifications of Installers:

1. For the actual fabrication, installation, and testing of the work, shall use only thoroughly trained and experienced personnel who are completely familiar with the requirements of this work and with the installation recommendations of the manufacturers of the specified items.

2. Utilize a full time project foreman in charge of all electrical work. This person shall be fully qualified and experience in such work and shall be available, on site, at all times during Construction. All problems, questions, coordination, etc. related to electrical work shall take place through this person to the Architect.

1.5. PERMITS, FEES, AND INSPECTIONS

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, 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.

F. State Mandated Electrical Inspections: The Contractor shall obtain electrical installation inspection from a non-governmental electrical inspector approved by the State Fire Marshal. The Contractor shall coordinate inspections, coordinate inspection schedule with the Owner, and obtain the electrical inspection certificate within 15 days after completion of electrical installation. The Contractor shall obtain electrical inspections of portions of the Work as they are completed and as required by the electrical inspector, and sufficiently ahead of close-in work so that corrections and re-inspections may be made, and in all cases while the area is accessible and visible for inspection.

1.6. 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.

1.7. 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 overhead ducts, piping, etc. Where any doubt exists, the exact location shall be determined by the Owner.

C. No electrical equipment, e.g. transformers, panelboards, disconnect switches, motor controllers, etc. shall be installed beneath ductwork, piping, etc.

D. All general trades and existing conditions shall be checked before installing any outlets, power wiring, etc.

E. 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.

F. 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.

G. 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.

H. Work not specifically outlined, but reasonably incidental to the completion of the work, shall be included without additional compensation from the Architect, Engineer, and Owner.

I. 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.

J. The complete set of Architectural, Civil, Structural, Food Service, Technology, Mechanical, and Electrical Drawings and Specifications apply to this work. The successful Bidder shall familiarize himself with all other related documents.

1.8. 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 relocated 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. 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. 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.

1.9. ELECTRICAL WORK UNDER OTHER DIVISIONS

A. Architectural Equipment and Systems

1. In general, any electrically operated or controlled equipment furnished under Architectural divisions shall be supplied with control wiring, transformers, contacts, etc.

2. Division 26 shall provide power circuits to such equipment and a disconnecting means for each piece of equipment, as well as all electrical control equipment and wiring related thereto.

3. Architectural Equipment refers to, but is not limited to the following:

a. Appliances
   i. Includes, but is not limited to refrigerators, microwaves, dishwashers, ranges, range hoods, clothes washers, clothes dryers, etc.
   ii. Verify equipment nameplates and connection requirements prior to rough-in.
   iii. Coordinate mounting heights and locations of outlet boxes serving appliances with approved appliance product data and approved casework shop drawings where applicable.

b. Cabinets, Casework and Countertops
   i. Do not install outlets, switches, etc. behind casework, cabinets, etc.
   ii. Receptacle outlets and data/telephone outlets shall be mounted above the countertops unless otherwise indicated.
   iii. Where outlets are installed below countertops, provide grommets through countertops for cabling. Coordinate drilling of casework/countertops with casework installer.
   iv. Coordinate outlets above and below countertops and associated surface raceways with approved casework shop drawings to avoid conflicts with sinks and other appurtenances.

c. Classroom Equipment
   i. Includes, but is not limited to television mounting brackets, projection screens, etc.
   ii. Verify equipment nameplates and connection requirements prior to rough-in.
   iii. Coordinate mounting heights and locations of outlet boxes serving equipment with approved product data and approved casework shop drawings where applicable.

d. Conveyance Systems
   i. Includes, but is not limited to, elevators, etc.

e. Door Hardware
   i. Includes, but is not limited to electric strikes, magnetic hold-open devices, power-assist door operators, raise/lower switches, etc.

ii. Verify voltages of door hardware with approved door hardware shop drawings.

f. Electric Hand Dryers

i. Verify voltage and overcurrent protection requirements with approved shop drawings.

ii. Coordinate mounting heights and locations of electric hand dryers with Architect.

g. Glazing Systems

i. Includes but is not limited to commercial storefront, curtain walls, skylights, windows, etc.

ii. Do not install fire alarm initiation and notification appliances on glazing systems wherever possible. Where devices must be installed on glazing systems, indicate the same on fire alarm system shop drawings and obtain the permission of the Architect.

iii. Coordinate installation of exit signs above doors that are integral to glazing systems. Conceal power wiring (MC cable) within glazing systems.

B. Civil Equipment and Systems

1. In general, any electrically operated or controlled equipment furnished under Civil divisions shall be supplied with control wiring, transformers, contacts, etc.

2. Division 26 shall provide power circuits to such equipment and a disconnecting means for each piece of equipment, as well as all electrical control equipment and wiring related thereto.

3. Civil Equipment refers to, but is not limited to the following:

a. Site Lighting

C. Food Service (Kitchen) Equipment and Systems

1. In general, any electrically operated or controlled equipment furnished under Food Service divisions shall be supplied with control wiring, transformers, contacts, etc.

2. Division 26 shall provide power circuits to such equipment and a disconnecting means for each piece of equipment, as well as all electrical control equipment and wiring related thereto.

3. Food Service Equipment refers to, but is not limited to the following:

a. Commercial Kitchen Appliances

i. Includes, but is not limited to refrigerators, freezers, warming cabinets, vending machines, cash registers, microwaves, dishwashers, garbage disposals, ranges, mixers, kettles, convection ovens, utility distribution systems, etc.

ii. Verify equipment nameplates and connection requirements prior to rough-in.

iii. Coordinate mounting heights and locations of outlet boxes serving appliances with approved appliance product data and approved

casework shop drawings where applicable.

D. HVAC Equipment and Systems

1. In general, any electrically operated or controlled equipment furnished under HVAC divisions shall be supplied with control wiring, transformers, contacts, etc.

2. Division 26 shall provide power circuits to such equipment and a disconnecting means for each piece of equipment, as well as all electrical control equipment and wiring related thereto.

3. Certain mechanical units are furnished from the factory with motor starters, contactors, transformers, fuses, wiring, etc., required for fans, pumps, etc. When this equipment is supplied from the factory, Division 26 shall coordinate with Division 23 such that only one set of starters, fuses, switches, etc. is provided.

4. Some HVAC equipment must be protected by fuses, which shall be marked on the equipment nameplate. In these instances, if the equipment has an integral non-fused disconnecting means, the fusible safety switch indicated on the electrical drawings must remain per NEC Article 440.

5. In general, control and interlock equipment (including, but not limited to wiring, conduit, transformers, relays, contacts, etc.) for HVAC equipment and systems is furnished under Division 23. Division 26 shall install and connect all equipment as necessary.

6. HVAC equipment refers to, but is not limited to the following:

    a. ATC Panels
    b. Boilers
        i. Coordinate connection type (i.e. switch or cord-and-plug) with approved shop drawings.
        ii. Coordinate emergency shut-down provisions (i.e. control circuit versus shunt-trip mechanism) with Division 22.
    c. Branch Selector Boxes
    d. Condensing Units
    e. Ductless Split Systems
    f. Ductwork
        i. Do not install any electrical equipment, including but not limited to switchboards, transformers, panelboards, safety switches, motor controllers, etc. beneath ductwork. Where this cannot be accomplished due to field conditions, notify the Architect and Engineer in writing.
    g. Electric Unit Heaters
    h. Energy Recovery Ventilators
    i. Exhaust Fans
    j. Fan Coil Units
    k. Heat Pumps
    l. Ventilation Fans

7. To ensure proper electrical coordination between the electrical components

supplied under Division 26 and the equipment supplied under Division 23, a schedule shall be submitted, prior to start of work, for review by the Engineer with the following column headings:

a. Equipment or Item
b. HP or KVA
c. Voltage and Phase
d. Power Factor
e. Capacitor
f. Motor Starter
g. Disconnect
h. Controls
i. Remarks

E. Owner Furnished Equipment and Systems

1. In general, any electrically operated or controlled equipment furnished by the Owner shall be supplied with control wiring, transformers, contacts, etc.

2. Division 26 shall provide power circuits to such equipment and a disconnecting means for each piece of equipment, as well as all electrical control equipment and wiring related thereto.

3. Owner equipment refers to, but is not limited to the following:

a. Existing Appliances and/or Equipment
b. Electronic Appliances
i. Includes, but is not limited to televisions, computers, copy/fax machines, printers, etc.
ii. Verify equipment nameplates and connection requirements prior to rough-in.
iii. Coordinate mounting heights and locations of outlet boxes serving appliances with approved appliance product data and approved casework shop drawings where applicable.
c. Kitchen/Laundry Appliances
i. Includes, but is not limited to refrigerators, microwaves, dishwashers, ranges, range hoods, clothes washers, clothes dryers, etc.
ii. Verify equipment nameplates and connection requirements prior to rough-in.
iii. Coordinate mounting heights and locations of outlet boxes serving appliances with approved appliance product data and approved casework shop drawings where applicable.

F. Plumbing Equipment and Systems

1. In general, any electrically operated or controlled equipment furnished under Plumbing divisions shall be supplied with control wiring, transformers, contacts, etc.

2. Division 26 shall provide power circuits to such equipment and a disconnecting

means for each piece of equipment, as well as all electrical control equipment and wiring related thereto.

3. Certain plumbing units are furnished from the factory with motor starters, contactors, transformers, fuses, wiring, etc., required for pumps, etc. When this equipment is supplied from the factory, Division 26 shall coordinate with Division 22 such that only one set of starters, fuses, switches, etc. is provided.

4. In general, control and interlock equipment (including, but not limited to wiring, conduit, transformers, relays, contacts, etc.) for plumbing equipment and systems is furnished under Division 22. Division 26 shall install and connect all equipment as necessary.

5. Plumbing equipment refers to, but is not limited to the following:

   a. Electric Water Coolers
      i. Coordinate mounting height and location of receptacle outlets serving electric water coolers with approved shop drawings.
   b. Floor Drains
      i. Coordinate routing of conduits and raceways in floor slabs with floor drains.
   c. Condensate Pumps
      i. Coordinate connection type (i.e. switch or cord-and-plug) with approved shop drawings.
   d. Piping
      i. Do not install any electrical equipment, including but not limited to switchboards, transformers, panelboards, safety switches, motor controllers, etc. beneath piping. Where this cannot be accomplished due to field conditions, notify the Architect and Engineer in writing.
   e. Sinks
      i. Provide weather-resistant NEMA 5-20R receptacle outlet with GFCI protection for control power transformer serving automatic lavatory faucets. Coordinate mounting height and location of receptacle outlets with approved shop drawings.
   f. Sump Pumps
      i. Coordinate sump pump control panel connection type (i.e. switch or cord-and-plug) with approved shop drawings.
      ii. Provide 2-inch conduit with pull string from control panel to sump pump for control and power cabling provided with equipment.
   g. Trap Priming Stations

1.10. 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.

1.11. 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.

1.12. SUBMITTALS

A. Product Data: Include complete descriptive product data for items specified in Part 2 of this Section.

1.13. SUBMITTAL PROCEDURES

A. Refer to Division 01, Section “Submittal Procedures” for requirements in addition to those

indicated herein.

B. 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, and/or Engineer, to be in the best interest of the Owner.

C. 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 as outlined below.

D. Electronic submittals shall be prepared as a Portable Document Format (PDF) file and shall include as page 1 the Contractor's stamp, followed by the submittal contents. Submittal form shall identify the Project, Contractor, Subcontractor or Supplier, and pertinent Contract Document references.

E. Submittals shall consist of specifications, product data sheets, manufacturer's catalog cuts, dimensional shop drawings, wiring diagrams, installation instructions, samples, and any other information necessary to indicate complete compliance with Contract Documents.

F. 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.

G. Identify submittals, indicating intended application, location and service of submitted items. Refer to Specification sections or paragraphs and Drawings where applicable.

H. Clearly indicate exact type, model number, style, size, operating characteristics, ratings, options and special features of proposed item specifically for application to this project. Submittals of a general nature will not be acceptable.

I. 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.

J. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and all electrical requirements for equipment submitted. The Contractor shall be responsible for correctness of all submittals.

K. 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.

L. 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.

M. 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.

N. Where proposals to use an item of equipment or application other than that specified or detailed on the Contract Drawings, which requires any redesign of the structure, partitions, foundation, HVAC, piping, wiring, or any other part of the mechanical, electrical, or architectural layout, all such redesign and all new drawings and detailing required thereafter shall be prepared by the Contractor at his own expense for review by the Owner's representative before any such work is implemented.

O. All Contractor-proposed changes and revisions shall be at the Contractor's risk and expense. The Contractor shall fully coordinate all revisions, substitutions and changes with other trades for a complete, code compliant, and fully functional installation.

P. 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.

Q. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct submittal. Identify all submittals by the name of the item/system and the applicable Specification Section and/or Drawing number. Grouping of items/systems that are not related shall be unacceptable.

R. Items and Systems

1. Access Doors
2. Arc Flash Hazard Labels
3. Circuit Breakers
4. Conductors and Cables - 600V or Less
5. Conduit and Raceway
6. Connectors and Splices
7. Disconnect (Safety) Switches
8. Electrical Connection Coordination Schedule
9. Emergency Off Push-Buttons
10. Emergency Transfer Relays
11. Enclosed Circuit Breakers
12. Equipment Nameplates/Labels
13. Firestopping Materials
14. Foam Duct Sealant

15. Fuses, 600V or Less
16. Ground Busbars
17. Ground Conductors
18. Grout
19. Handholes
20. Hangers and Supports
21. Identification Products
22. Installation/Coordination Drawings
23. Installer Certificates
24. Junction and Pull Boxes
25. Lighting Calculations
26. Lighting Control System
27. Lighting Fixtures, Exterior
28. Lighting Fixtures, Interior
29. Lightning Protection System
30. Motor Controllers
31. Operation and Maintenance Manual
32. Outlet and Device Boxes
33. Panelboard Circuit Directories
34. Panelboards
35. Qualification Data
36. Receptacles
37. Record Drawings
38. Roof Penetration Boots /Curbs
39. Sleeves
40. Surface Metal Raceway

41. Surface Non-Metallic Raceway

42. Surge Protective Devices

43. Switchboards

44. Testing Agency Qualifications

45. Test Reports

46. Toggle/Snap Switches

47. Transformers, 600V and Less

48. Underground Ductbank Products

49. Weatherproof Boxes and Covers

50. Wiring Diagrams

S. Submit for approval any other submittals as required by the Architect, Engineer, or Owner. 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.

T. 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.

U. For resubmissions, the Contractor must address in writing all of the Engineer's comments on the original submission to verify compliance.

1.14. 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. Shop drawings shall include identification of products being installed, compliance with specified standards, notation of coordination requirements, notation of dimensions verified by field measurement, etc. Do not base shop drawings on reproductions of the Contract Documents or standard printed data.

C. Submit shop drawings concurrent with product data. Shop drawings received without associated product data will be returned without review.

D. Submit for approval schematic diagrams of each electrical system installed in the building, including but not limited to Riser Diagrams and Schematic Wiring Diagrams for the following systems:

1. Emergency Power Supply System – Generator and Transfer Switch(es)

2. Lighting Control System

3. Lightning Protection System

4. Occupancy Sensor Layout

E. Shop Drawing 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 inserted into the O&M Manual specified herein.

F. Submit for approval any other shop drawings as required by the Architect, Engineer, or Owner. 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.

G. 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.

H. Refer to individual Specification Sections and Contract Drawings for additional shop drawing requirements.

I. For resubmissions, the Contractor must address in writing all of the Engineer’s comments on the original submission to verify compliance.

1.15. 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, or embedded in construction, or in crawl space or attic.

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.

1.16. 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.

1.17. 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 (2) 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.

1.18. OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall have prepared six (6) hardcopies and one (1) electronic copy of the Operation 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 and spine of the binder: Operation and Maintenance Manual –Cape Henlopen High School Expansion - 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.

C. Provide divider tabs and table of contents for organizing and separating information. Tab titling shall be clearly printed under reinforced plastic tabs.

1. If more than one (1) binder is required, volume numbers shall be included on front and spine of each volume.

D. 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. Directory listing names, addresses, e-mail addresses, and telephone numbers for Architect, Engineer, Construction Manager, Contractor, Sub-contractor(s), equipment suppliers, sales and authorized service representatives.

3. Maintenance operation and lubrication instructions on each piece of equipment furnished.

4. Complete catalog data on each piece of electrical equipment furnished including approved Shop Drawing/Submittal with Engineer's Comments (if any).

5. Manufacturer's extended limited warranties on equipment.

6. Catalog data of all equipment, starters, etc. shall include wiring diagrams, parts list and assembly drawing(s).

7. Access panel charts with index illustrating the location and purpose of access panels.

8. Approved Electrical Certificates, including certificate of approval from electrical inspector.

9. List of extra materials turned over to Owner, with transmittal/receipt signed by Owner.

10. Sign-in sheets from demonstration and training sessions.

11. Start-up and test reports for equipment.

E. Additional items identified within other Sections of these Specifications.

F. Submit Operation and Maintenance Manual prior to the anticipated date of Substantial Completion for Engineer review and approval. Substantial Completion requires that Operation and Maintenance Manuals be reviewed and approved.

1.19. INSTRUCTION

A. Upon completion of all work, thoroughly instruct the Owner's representatives in the proper operation and maintenance of all electrical equipment and systems.

B. Instructions shall be done only after completed systems have been put into operation and tested for proper operation and performance.

C. 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.

D. Furnish the necessary technicians, skilled workers, and helpers to operate the electrical systems and equipment of the entire project for one (1) 8-hour day.

E. Where specified in technical sections, provide longer periods required for specialized equipment.

F. The Operation and Maintenance Manual shall be available at the time of the instructions, for use by Instructors and Owner personnel.

G. Deliver all instruction materials to the Owner prior to the formal instruction period.

H. Schedule the general and specialized instruction periods for a time agreed upon by the Owner and Engineer.

1.20. DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Architect Engineer.

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.

D. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.

1.21. 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 and ductbanks.

3. 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 complete set of Architectural, Civil, Structural, Technology, Mechanical, and Electrical Drawings and Specifications apply to this work. The successful bidder shall familiarize himself with all other related documents 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.

2.2. GROUT

A. Nonmetallic, Non-Shrink 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.

2.3. 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 ten sile 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).

2.4. BACKBOARDS

A. Backboards: Plywood, A/C grade, fire-retardant treated, ¾” x 48” x 96” (19 x 1220 x2440 mm) with no added urea formaldehyde.

B. Install each fire-retardant-treated plywood backboard six inches off the floor to bottom. Secure backboards with a minimum of eight (8) screws. Plywood backboards shall have one side with exterior glue and one finished smooth side. Mark all backboards and cabinets with appropriate legends (e.g., "COMM").

C. Verify with local codes or AHJ prior to painting fire-retardant-treated plywood backboard with stamped fire rating labels. If allowed by code, paint fire-retardant-treated plywood backboard with coats of durable white enamel (or other finish color as selected by the Architect).

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.

2.6. PROTECTIVE WIRE GUARDS/SHIELDS

A. Provide protective guards over devices subject to physical damage. All new devices installed in, in mechanical and electrical rooms, 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 (Horns, Strobes, etc…)

9. Exit Signs

10. Emergency Lighting Units

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. Wireguards shall be fabricated from ¼-inch (9-gauge) cold-rolled steel rods, welded together with mounting tabs. Wireguards 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. Indoor Protective Shield: Factory-fabricated, clear thermoplastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

E. Protective guards/shields 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.

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, including step-down or step-up dry-type transformers as required. Exact requirements for temporary service shall 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. Materials:

1. Lights at each floor in each stair. At least one light outlet per 900 square feet on

each floor exclusive of stairs.

2. One 20-ampere circuit with ground fault protection for each 7500 square feet of gross floor area per floor to which various trades may attach their cords.

3. One temporary power line in each corridor elevator and lobby, including connections to saws, if required, with ground fault protection.

4. Power for testing and operating of elevators.

E. Installation: Temporary lighting shall provide minimum foot candle levels for construction as follows:

AREA	FOOT CANDLE LEVEL
General construction area lighting, corridors, hallways and exit ways.	5
Electrical equipment rooms, active storerooms, shops, locker and dressing areas	10

F. The Contractor shall pay for all energy charges for temporary service.

G. Obtain and pay for temporary electrical service for construction power.

H. Provide all underground and/or overhead equipment, transformers, overcurrent devices, wires, connections, etc., for obtaining power from the existing electrical distribution system.

I. Remove all temporary power installations and connections after permanent power is established and/or prior to completion of the project.

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 NEC Article 110.

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 requirements for each piece of equipment receiving one or more electrical connections, including but not limited to voltage, phase, and maximum fuse/overcurrent protection device rating. Provide electrical circuit of proper characteristics to serve provided equipment.

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. Make all connections to equipment in accordance with manufacturer's instructions.

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

K. Coordinate electrical work under other Divisions in accordance with Part 1 of this Section, Article "Electrical Work Under Other Divisions".

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. 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.

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

E. Sleeves installed in floors shall extend 2 inches (50 mm) above finished floor level unless otherwise indicated on the Contract Drawings.

F. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

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

H. 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 "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

07 Section, "Penetration Firestopping" and Division 26 Section “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 pipe sleeves and joint sealant/grout.

3.4. 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".

3.5. 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 interior pad-mounted equipment, extending a minimum of 6 inches beyond equipment bases, unless otherwise noted.

2. 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.

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

4. 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.

5. Determine exact location of all equipment, foundations, and supports after Shop Drawings of equipment have been approved.

D. Refer to Division 26 Section “Hangers and Supports” for additional requirements.

3.6. 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 in accordance with OSHA 29 CFR 1910 Subpart D and 1910.303(g).

3.7. 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, conduit, boxes, 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, boxes, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

3.8. COLOR SELECTION

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

3.9. 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.

3.10. 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 "Temporary Facilities and Controls".

E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items.

3.11. 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 and Engineer for approval.

3.12. WALL AND FLOOR PENETRATIONS

A. All penetrations of partitions, ceilings, roofs and floors under Division 26 shall be sleeved, sealed, and caulked as specified herein.

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. 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.

D. 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.

3.13. 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.

3.14. 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. 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 facility and Architect can be aware of the areas of construction and progress as it relates to the approved schedule.

F. 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.

3.15. OUTAGES

A. Provide a minimum of seven (7) 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.

3.16. 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 [Structural] Engineer.

3.17. 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 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.

3.18. 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 achieve compressive strength not less than 3,000 psi 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. 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:

1. Slabs - 3/4 inch

2. Concrete poured against earth - 3 inches

3. Other locations - 2 inches

E. Properly align, level, and grout all equipment where necessary.

3.19. 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.

3.20. 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 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.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 26 Section "Electrical Firestopping".

3.21. 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. Where any abandoned conduits in existing floors, walls, ceilings, etc., conflict with new work, remove abandoned conduits as necessary to accommodate new work.

E. 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.

F. Maintain egress at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and the Authority(ies) Having Jurisdiction (AHJ).

G. Make provisions and include in bid all costs associated with confined entry/space

requirements in crawl spaces and all other applicable OSHA regulations.

H. 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.

I. At completion of project all temporary conduit, wires, etc., shall be removed in their entirety.

J. Existing conduit, equipment, wiring, etc., not required for re-use or re-installation in this project, shall be removed from the project site.

K. 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.

L. 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.

M. 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.

N. 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.

O. 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.

P. The Owner shall have the first right of refusal for all fixtures, devices and equipment removed by the Contractor.

Q. 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.

R. 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.

S. 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.

T. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make

operational equipment indicated for relocation.

U. Terminate services and utilities in accordance with local laws, ordinances, rules and regulations.

3.22. 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:

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 other applicable Guidelines.

3. Keep excavations dry. Protect excavations from freezing.

C. Backfilling:

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 FORM

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)

PART 1 (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 260510
ELEVATOR EQUIPMENT WIRING AND PROVISIONS
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SECTION 26 05 10

ELEVATOR EQUIPMENT WIRING AND PROVISIONS

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. WORK INCLUDED

A. Power wiring and devices to elevator drive equipment.

B. Power wiring and devices for elevator cab equipment.

C. Additional miscellaneous service connections may include:

1. Telephone service connection.
2. Public address system connection.
3. Emergency power system connections.
4. Elevator lobby smoke detector connections.
5. Safety light and outlet in elevator pit.

D. Elevator control wiring and interlock controls not included.

E. All electrical work specified to be done by others in Division 14**.**

1.3. COORDINATION

A. Coordinate with elevator contractor, elevator inspector, electrical inspector, and Fire Marshal prior to installation.

B. Prepare coordination drawings and sketches as needed to provide complete information.

C. Coordinate with other trades to avoid foreign equipment, not dedicated to serving Elevator from being installed in Elevator.

D. Coordinate entire installation with elevator system installer prior to rough-in and prior to installation of equipment.

E. Coordinate location of lights, machines, and equipment installed in elevator pit with elevator system installed on site prior to installation.

1.4. REGULATIONS

A. Comply with NEC.

B. Comply with NFPA: NFPA 101 Life Safety Code.

C. Comply with ANSI/ASTM Elevator Code.

D. Comply with BOCA Building Code.

PART 2. PRODUCTS

2.1. MANUFACTURERS

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

1. Disconnect Switches

a. Refer to Division 26 Section “Disconnect Switches”

PART 3. EXECUTION

3.1. GENERAL INSTALLATION REQUIREMENTS

A. Locate all disconnect devices and elevator light switch on lock side of door within elevator. Devices are typically located within 1'-6-inches of entrance.

B. Ensure that no electrical conduits, raceways, etc. are routed over elevator shaft.

C. Work performed under Division 26 shall not create openings in elevator shaft walls or ceilings, unless specifically serving items in elevator shaft pit. All penetrations shall be sealed with firestopping materials to maintain fire rating of elevator shaft.

3.2. ELECTRICAL PROVISIONS

A. Provide lockable, heavy duty type, fused disconnect switches to serve circuits serving elevator cab power (lighting/ventilation), for elevator drive, and if required for signal power. Provide fuses sized as directed by elevator supplier. Provide in accordance with NEC Articles 620-22 (a), 620-53, and 620-85.1. Disconnect switches shall be lockable in the “open” position and the “closed” position. Provide each disconnect with an equipment nameplate to identify the location of the supply side overcurrent protection device.

B. Install fused disconnect switches adjacent to elevator equipment room door. Locate on strike side of door. Provide one disconnect switch for each elevator controller unit.

C. Provide all power wiring from source through disconnect to elevator controller to motor.

D. Provide 1-inch conduit, with pull string cables from each elevator controller to the nearest telecommunications closet.

E. Provide lock-clip devices on each circuit breaker serving elevator car and room, both lighting and power circuits.

F. Provide shunt trip circuit breaker serving each elevator controller. Connect to heat

detectors as required. Provide power to shunt trip unit as required. Size per elevator supplier directions.

G. Provide light fixtures and duplex GFCI receptacle serve elevator pit. Provide switch adjacent to access ladder near the hoistway door, 36-inch above door sill. Provide switch, receptacle, on every other floor above the lowest level for each elevator. Provide in accordance with NEC Articles 620-24 and 620-85.

H. All traveling cables, control stations, control station wiring and final control connections at the controller shall be furnished and installed under Division 14.

I. Provide elevator machine room lighting and receptacles in accordance with NEC Articles 620-23 and 620-85. Locate lights in room to provide optimum illumination for all machinery, and the front and rear of each controller. Provide light switch by the machine room entrance.

J. Provide for each elevator car a separate dedicated 120 volt, 20 ampere branch circuit with a lockable fused, disconnect switch in the elevator machine room, with two (2) 12 AWG and one (1) 12 AWG ground in ¾-inch conduit, to each elevator controller, to serve car lighting, ventilation and car top receptacle.

3.3. FIRE ALARM PROVISIONS

A. Provide smoke detector in each elevator equipment room or space. Connect main alarm contacts to fire alarm system and auxiliary contacts to the controller per BOCA 2611.4 and ANSI/ASME A17.A. Provide remote indicating lamp unit at door.

B. Provide heat detectors within 24-inches of each fire protection sprinkler head in the elevator shaft and elevator machine room. Connect heat detectors to shunt trip breaker serving elevator.

C. Provide fire return/recall smoke detector in each elevator lobby within five (5) feet of elevator entrance. Connect main alarm contacts of fire alarm system and auxiliary contacts to elevator controller. Provide two (2) 18 AWG in ¾-inch conduit to elevator terminals as directed by Elevator Contractor.

D. Provide fire alarm control modules and monitoring modules as required per Specifications and codes.

E. Provide two (2) 18 AWG wiring in ¾-inch conduit from each elevator lobby smoke detector to each elevator controller in the Elevator Machine Room.

F. Provide dedicated fire alarm system valve tamper switch and water flow switch at the following locations:

1. At the top of each elevator shaft.

2. In each elevator pit.

3. In each Elevator Machine Room.

G. Provide smoke detectors at the top of each elevator shaft. Provide remote indicating lamp unit at top floor elevator lobby and connect to smoke detector.

3.4. EMERGENCY POWER PROVISIONS

A. Feed elevator cab lights from emergency power source.

END OF SECTION

DIVISION 26 SECTION 26 05 12
KITCHEN EQUIPMENT WIRING
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SECTION 26 05 12

KITCHEN EQUIPMENT WIRING

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. WORK INCLUDED

A. Kitchen equipment wiring, including:

1. Power service connections.

2. Fire alarm connections.

3. Light switch for control of hood lights.

4. Control wiring specifically shown on Electrical and/or Kitchen Equip¬ment Drawings.

B. All line and disconnect switches, safety cut-offs and fittings, convenience boxes or other electrical controls, fittings and connections will be furnished and installed under electrical contract by Division 26, unless specifically indicated otherwise in the item specifications. Starting switches for certain specified pieces of food service equipment are to be provided by Kitchen Equipment Contractor. Those starting switches, if furnished loose as standardized by Foodservice Manufacturers (other than fabricated items), shall be mounted and wired complete under Division 26.

1.3. SUBMITTALS

A. Provide dimensioned equipment layouts, detailed shop drawings of equipment showing locations and method of installing loose equipment and making final connections, and wiring and control diagrams.

PART 2. PRODUCTS

2.1. WIRE AND CABLES

A. Refer to Division 26, Section “Conductors and Cables”. All wiring to the kitchen equipment shall be THWN/THHN.

B. Where heating elements are involved in equipment supplied, provide moisture resistant wire having suitable temperature rating for service conditions.

C. All wiring in Kitchen hoods and in other high ambient temperature areas shall be of types required by NEC.

2.2. OUTLET BOXES

A. Refer to Division 26, Section “Raceways and Boxes”.

B. In making connections to disposers, dishwashers, and similar units where moist conditions are encountered, provide NEMA 4 boxes, covers, and fittings.

2.3. CONDUIT

A. Refer to Division 26, Section “Raceways and Boxes”.

B. Provide only rigid steel conduit, zinc-coated, where concealed, and shall provide only rigid steel chrome-plated where exposed. All wiring and conduit shall be run concealed wherever possible.

C. Provide liquid tight flexible metal conduit connections to all direct connected equipment.

2.4. COVER PLATES

A. Refer to Division 26, Section “Wiring Devices”.

B. Provide brushed stainless steel plates for receptacles located in stainless steel backsplash.

C. Provide weatherproof cover plates for all receptacles in damp locations.

2.5. DISCONNECT SWITCHES

A. Refer to Division 26, Section “Disconnect Switches and Circuit Breakers”.

B. Provide NEMA 4X stainless steel type enclosures for safety switches serving kitchen equipment.

2.6. CORDS AND CAPS

A. Straight-blade Attachment Plug: NEMA WD 1.

B. Locking-blade Attachment Plug: Match receptacle configuration at outlet provided for equipment.

C. Cord Construction: Oil-resistant thermoset insulated Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for extra hard usage in damp locations.

D. Cord Size: Suitable for connected load of equipment and rating of branch circuit overcurrent protection.

2.7. SWITCHES AND CONTROLS

A. Provide recognized commercial grade signals, On-Off pushbuttons or switches, and other speed and temperature controls as required for operation of each item, complete with pilot lights and permanent graphics, conspicuously labeled, to assist the user of each item.

B. Mount switches and controls directly adjacent to the piece of equipment for which it involves, on operator’s side of counter body apron, out of view to the public.

C. Provide on or for each motor-driven appliance or electrical heating or control unit, a suitable control switch or starter of the proper type and rating and in accordance with Underwriter's Code, wherever such equipment is not built in. All line switches, safety cut-outs, control panels, fuse boxes, other control fittings and connections, when not an integral part of the unit or furnished loose by the manufacturer, will be furnished and installed by the Contractor, unless otherwise specified. All electrical controls, switches, or devices provided loose for field installation as a part of the item specified be installed in the field by the contractor unless otherwise specified.

D. Appliances shall be furnished complete with motors, driving mechanisms, starters, and controllers, including master switches, timers, cut-outs, reversing mechanisms, and other electrical equipment if and as applicable.

2.8. OTHER PRODUCTS

A. Refer to related sections for other product requirements.

B. Provide three- or four-wire, grounding-type receptacles for all wall and floor-mounted outlets to be used for plug-in equipment with characteristics as noted on the drawings. Provide "Hubbell", or approved equal, three-wire or four-wire grounding-type connectors and neoprene cords installed on each item of plug-in equipment, as indicated on drawings and item specifications.

C. Provide receptacles to match the specific plugs provided as part of the plug-in equipment. Any changes in cords and plugs required in the field due to lack of coordination shall be the Contractor's responsibility.

D. Reduce the length of all cords furnished with the specified equipment to a suitable or appropriate length so they do not interfere with other equipment or operations.

E. Pedestal receptacles that are part of fabricated equipment exposed to view, shall be similar to T&S Model #B-1508DD single face, single gang or Model #B-1528DD single face, double gang.

F. All 120 volt, 20 amp receptacles in kitchen area shall be GFI (Ground Fault Circuit Interrupting) type to meet requirements of NEC – Article 210.8(B).

PART 3. EXECUTION

3.1. COORDINATION

A. Locations of outlet boxes, conduit stubs and connection points shown on drawings are for bidding purposes only. Determine exact locations for outlet boxes, conduit stubs and connection points from approved shop and setting drawings prepared by Kitchen Equipment Contractor.

B. Confirm rating of each item of equipment with kitchen equipment supplier before installing breakers and wiring.

3.2. INSTALLATION

A. Kitchen equipment to be supplied and set in place by other trades, complete with all motors, heating elements and automatic controls. Except where otherwise noted, motor protection switches and control stations shall be supplied as part of equipment. Provide wiring and electrical connections to kitchen equipment. Connect to panel or junction box of prewired equipment.

B. Rough-in location shall be within three inches of the equipment. If direct connection is required, use Sealtite. If receptacle connection is required, verify proper receptacle configuration with equipment installer.

C. Final connections shall include extension of all service to each piece of equipment. All labor and material required to completely connect the equipment ready to operate shall be included in the final connections. All control wiring not integral with equipment shall be included.

D. Equipment Contractor shall provide services of their representatives and/or Equipment Manufacturer's Representative at appropriate stage of construction to answer the Contractor's questions concerning the final connections. All control wiring not integral with equipment shall be included.

E. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.

F. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit in damp or wet locations.

G. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.

H. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.

I. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.

J. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated. Connect with conduit and wiring as indicated.

END OF SECTION

DIVISION 26 SECTION 26 05 19
CONDUCTORS AND CABLES
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CONDUCTORS AND CABLES

PART 1. GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3. SUBMITTALS

A. Product Data: Provide for each cable assembly type, wire, cables, conductors, and connectors.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Indicate procedures and values obtained.

C. Project Record Documents: Record actual locations of components and circuits.

1.4. QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to requirements specified in Division 01 Section, "Quality Control", an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907; or shall be a full member company of the International Electrical Testing Association.

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 of this Section.

B. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.

1. The Terms Listed and Labeled: As defined in NFPA 70, Article 100.

2. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory as defined in OSHA Regulation 1910.7.

C. Comply with NEMA/Insulated Cable Engineers Association (ICEA) Standards.

D. Comply with NECA Standard of Installation.

E. Comply with NETA ATS - Acceptance Testing Specifications for Electrical Power

Distribution Equipment and Systems.

F. American Society for Testing and Materials (ASTM): Comply with requirements of the following:

1. B3: Standard Specification for Soft or Annealed Copper Wire

2. B8: Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

3. D753: Standard Specification for General Purpose Polychloroprene Jacket for Wire and Cable

G. Electrical Testing Laboratories (ETL): Provide wiring, cabling and connector products which are ETL listed and labeled.

H. Institute of Electrical and Electronics Engineers (IEEE): Comply with the following standards which apply to wiring systems:

1. 82: Test procedure for Impulse Voltage Tests on Insulated Conductors

2. 241: Recommended Practice for Electric Power Systems in Commercial Buildings

I. NFPA: Comply with NFPA 70 requirements for construction, installation and color coding of electrical wire, cable and connections.

J. National Electrical Manufacturer's Association (NEMA): Comply with requirements of the following:

1. WC70: Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.

K. UL: Provide material conforming to the following standards:

1. UL 83 - Thermoplastic-Insulated Wires and Cables.

2. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors

L. UL Labels: Provide wiring, cabling and connector products which are UL listed and labeled.

1.5. DELIVERY, STORAGE, AND HANDLING

A. Deliver wires and cables according to NEMA WC 26, Binational Wire and Cable Packaging Standard.

B. Storage: Store wire and cable in a clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.

C. Handling: Handle wire and cable carefully to avoid abrading, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of

wires/cables is maintained.

1.6. COORDINATION

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

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

C. Determine required separation between cables and other work.

D. Determine cable routing to avoid interference with other work.

1.7. PROJECT CONDITIONS

A. Verify that field measurements are as shown on the Drawings.

B. Feeder conductor sizes are based on copper as indicated on the "Feeder Schedule" on the Contract Drawings.

C. Branch circuit conductor sizes are based on copper.

D. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.

E. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2. PRODUCTS

2.1. MANUFACTURERS

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

1. Wires and Cables:

   a. American Insulated Wire Corp.
   b. BICC Brand Rex Company.
   c. General Cable.
   d. Senator Wire & Cable Company.
   e. Southwire Company.
   f. Colonial Wire Company.

2. Connectors and Accessories for Wires and Cables:

   a. 3M Company; Electrical Products Division.
   b. AMP Incorporated.
   c. Buchanan.
   d. General Signal; O Z/Gedney Unit.
   e. Greaves Corporation.

f. Ideal Industries.
g. Monogram Company; AFC.
h. NSI Industries, Inc.
i. Square D Company; Anderson.

3. Metal Clad (MC) Cable

a. Alcan Cable.
b. Atkore AFC Cable Systems.
c. Encore Wire Corporation.
d. General Cable.
e. Nexans.
f. Prysmian Cables and Systems.
g. Service Wire Company.
h. Southwire Company.
i. United Copper Industries.

4. Metal Clad (MC) Connectors

a. Arlington Industries, Inc.
b. Bridgeport.
c. Crouse-Hinds.
d. Thomas & Betts.

2.2. BUILDING WIRES AND CABLES

A. UL-listed building wires and cables with conductor material, insulation type, cable construction and rating as specified herein.

B. Building wires and cables shall be annealed (soft) copper, 600 volt, Type THHN/THWN (dual-rated) single conductors rated 90°C dry / 75°C wet, with a minimum conductivity of 98 percent at 20°C (68°F), or a maximum resistivity of 1.7 micro-ohms per centimeter.

C. Conductors shall meet or exceed requirements of all applicable ASTM specifications, UL Standard 83, UL Standard 1581, NEMA WC 70, Federal Specification A-A-59544 and shall be RoHS/REACH Compliant.

D. Conductors shall be solid for 10 AWG and smaller, and stranded for 8 AWG and larger.

E. Building wire and cables shall be color-coded using colors factory impregnated throughout the insulation and jacket. The following color code convention(s) shall be used except where existing systems have established another color code convention:

1. 120/208-Volt, 3-Phase, 4-Wire System:

a. Phase A: Black
b. Phase B: Red
c. Phase C: Blue
d. Neutral: White
e. Ground: Green

2. 277/480-Volt, 3-Phase, 4-Wire System:

a.	Phase A:	Brown
b.	Phase B:	Orange
c.	Phase C:	Yellow
d.	Neutral:	Gray
e.	Ground:	Green

2.3. CONNECTORS AND SPLICES

A. UL listed, factory fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 Article, “Wire and Insulation Applications”.

B. Split Bolt Connectors: Not acceptable.

C. Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment pads or terminals. Not approved for splicing.

D. Spring Wire Connectors: Not acceptable.

E. Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.

F. Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic high conductivity copper tubing, internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps.

G. Heat shrinkable tubing shall meet the requirements of ANSI C119.1-1986 for buried connections to 90 degrees C and shall be material flame-retarded per IEEE 383 Vertical Tray Flame Test.

H. Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and a high dielectric strength mastic to seal the ends against ingress of moisture and contamination. Motor connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations. Connection kits shall be independent of cable manufacturer's tolerances.

I. Wire Nut Connectors:

1. Description: Twist-on wire connectors for branch circuit conductors 10 AWG and smaller with a color-coded housing.

2. Construction: Flame-retardant polypropylene housing, rated for 105 degrees Celsius. Zinc-plated steel insert. Square-wire spring to maintain secure positive grip that will not relax over time, no pre-twisting required.

3. Dimensions: Connectors shall be appropriately sized according to manufacturer’s recommendation for the suitable wire sizes and voltage rating (600 volts

minimum).

4. Quality Assurance:

   a. UL Listed to 486C and 94V-2 Flame Rating.
   b. CSA Certified to C22.2 No. 188
   c. RoHS Compliant

5. Special Features:

   a. Wire connectors for making grounding connections shall have green-colored housing and shall have opening at end of connector for grounding conductor to pass through for connection to metallic outlet boxes.
   b. Wire connectors for all exterior and underground work and work in damp/wet interior locations shall be pre-filled with silicone-based sealant to protect against moisture and corrosion, and shall be UL Listed to 486D for use in damp/wet locations, including direct burial applications.
   c. Wire connectors for high temperature applications, e.g. high-wattage lighting fixtures and signs, shall be UL listed to 150 degrees Celsius, and shall have a black fire-retardant plastic shell design to withstand heat build-up.

6. Basis of Design: Provide products by Ideal Industries, Inc. or approved equal.

J. Gel Tap Splices (for Conductors 10 AWG and Smaller in Damp/Wet Locations)

1. Description: Gel sealant filled splice for buried, underground, and overhead applications for low voltage (1000V or less) circuits. Protects connections from moisture ingress, corrosion, and pollution.

2. Construction: Range-taking mechanical connector made of aluminum accepts both aluminum and copper conductors. Molded cover of UV stable, impact resistant polypropylene provides rugged protection. Silicone gel is hydrophobic dielectric insulation and provides constant pressure on cable and connector to provide water seal. Seal is specially formulated for high temperature environments.

3. Dimensions: Splices and connectors shall be appropriately sized according to manufacturer's recommendation for the suitable wire sizes and voltage rating.

4. Quality Assurance: UL listed.

5. Special Features: Silicone gel shall easily peel away from connector, leaving a clean connection. Splices shall be rated for temperatures from -40 degrees Celsius to 90 degrees Celsius.

6. Basis of Design: GTAP Series as manufactured by Raychem/Tyco, or approved equal.

K. Insulated Connectors (for Conductors 8 AWG and Larger in Dry Locations)

1. Description: Multi-conductor connectors for low voltage (600V or less) circuits,

insulated with high-dielectric strength plastisol, molded for precise fit and supplied with removable access plugs over the hex screws.

2. Construction: Range-taking mechanical connector made of aluminum accepts both aluminum and copper conductors. Molded cover of UV stable, impact resistant polypropylene provides rugged protection. Mounting holes at each end of the connector for direct isolated mounting to wiring trough, panelboard, or wireway.

3. Dimensions: Splices and connectors shall be appropriately sized according to manufacturer's recommendation for the suitable wire sizes, quantities, and voltage rating.

4. Quality Assurance: UL listed. UV resistant.

5. Special Features: Connectors shall be rated for temperatures from -45 degrees Celsius to 90 degrees Celsius.

6. Basis of Design: IPLM/IPLMD Series as manufactured by Polaris, or approved equal.

L. Gel Filled Insulated Connectors (for Conductors 8 AWG and Larger in Damp/Wet Locations)

1. Description: Multi-conductor connectors for low voltage (1,000V or less) circuits, insulated with high-dielectric strength plastisol, molded for precise fit and supplied with removable access plugs over the hex screws. Gel-filled for damp/wet or submersed locations to protect connections from moisture ingress and corrosion.

2. Construction: Range-taking mechanical connector made of tin-plated aluminum accepts both aluminum and copper conductors. Molded cover of UV stable, impact resistant polypropylene provides rugged protection. Cable entry ports and hinged screw port caps shall be sealed with hydrophobic dielectric gel insulation.

3. Dimensions: Splices and connectors shall be appropriately sized according to manufacturer's recommendation for the suitable wire sizes, quantities, and voltage rating.

4. Quality Assurance: ANSI C119.1 for complete unit, ANSI C119.4 for connector, ASTM D543 for chemical resistance, ASTM G-53-95 and ASTM D-638-95 for UV resistance.

5. Special Features: Silicone gel shall be easily removed from conductor for re-entry. Connectors shall be rated for temperatures from -40 degrees Celsius to 95 degrees Celsius.

6. Basis of Design: GPRT Series as manufactured by Raychem/Tyco, or approved equal.

2.4. METAL CLAD (MC) CABLE

A. Cable shall meet or exceed the requirements of UL Standard 83, UL Standard 1063, and

UL Standard 1569 for Type MC cable, Federal Specification A-A59544 Vertical Cable Tray Flame Test and the National Electrical Code. Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.

B. Cable shall be constructed with soft drawn copper, 600 volt, type THHN/THWN conductors rated 90°C dry/75°C wet, with a green insulated grounding conductor. Conductors shall be cabled together with a binder tape bearing a print legend that is wrapped around the assembly. An aluminum interlocked armor shall be applied over the assembly. Conductors shall be protected by an anti-short bushing at each termination.

C. Cable serving lighting fixtures and/or lighting control devices with 0-10V dimming controls shall have 16 AWG copper TFN insulated single conductors within interlocked armor. Control conductors shall have purple and gray insulation/jacketing.

D. Only cables with conductor sizes 12 AWG and 10 AWG shall be permitted.

E. Multi-circuit MC cable is not permitted.

2.5. METAL CLAD (MC) CABLE CONNECTORS

A. Snap-In Connectors

1. Snap-in connectors for metal clad cable shall be constructed of die-cast zinc, shall be compatible with steel and aluminum cables, and shall have the following features:

   a. Insulated throat
   b. Removable ring to secure connector to box
   c. Angled, two-prong clip to secure cable
   d. Removable screw to secure cable clip

2. Snap-in connectors shall be available in a variety of sizes and configurations to accommodate different cable sizes/diameters, wire counts, cable counts, etc.

3. Single connectors shall be compatible with 1/2-inch knockouts. Duplex connectors shall be compatible with 3/4-inch knockouts.

4. Provide SNAP^{2}IT connectors as manufactured by Arlington Industries, Inc., or approved equal by listed manufacturer.

B. Lock-Nut Connectors

1. Straight connectors shall be one-piece spring-steel, set screw design with nylon insulator and locknut. Provide ACB series, as manufactured by Crouse-Hinds, or approved equal.

2. 45 and 90 degree connectors shall be die cast zinc, clamp type with insulated throat and locknut. Provide ACBXX45 or ACBXX90 series as manufactured by Crouse-

Hinds, or approved equal.

2.6. INSULATING TAPE, PUTTY, RESIN AND SUPPORTS

A. Tape: Provide plastic electrical insulating tape which is flame-retardant, cold and weather-resistant. Tape for use in areas subject to temperatures 30 degrees C to 105 degrees C, or where the tape will be subjected to an oil splash, tape shall have a minimum thickness of 8.5 mils, and shall consist of an oil-resistant acrylic adhesive.

B. Materials: Provide all insulating materials for splices and connections such as glass and synthetic tapes, putties, resins, splice cases, or compositions of the type approved for the particular use, location, voltage and temperature and apply and install in an approved manner, all in accordance with the manufacturer's recommendations.

C. Supports: Provide cable supports of the wedge type which firmly clamp each individual cable and tighten due to the cable weight.

PART 3. EXECUTION

3.1. EXAMINATION

A. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. By beginning work, the Contractor has accepted conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.2. PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3. WIRE AND INSULATION APPLICATIONS

A. No branch circuit wires smaller than 12 AWG shall be used unless otherwise indicated. Conductors shall be continuous from outlet to outlet and from terminal board to point of final connection, and no splice shall be made except within outlet or junction boxes. All conductors shall be of the size indicated. All wires 8 AWG and larger shall be stranded.

B. Control wiring shall not be less than 14 AWG and shall be color coded using colors impregnated into the insulation. All control wiring shall be color coded with wires of colors different from those used to designate phase wires.

C. All wiring, contacts, and terminal blocks shall be suitably tagged for ease in identification and tracing of circuits. Identification tags shall be engraved fiber or plastic type, subject to acceptance. Wires shall be numbered and coded, using Brady Quicklabels, or equal.

D. Wiring shall be tagged at terminations, in pull boxes, junction boxes, outlet boxes,

panelboards, etc…

E. Switch leg wire shall be labeled with “S” tag.

F. Wiring for general 15 and 20 amp branch circuit work shall be as follows unless otherwise indicated:

HOME RUN LENGTH AND WIRE SIZE				CIRCUIT LENGTH AND WIRE SIZE			
120 Volt		277 Volt		120 Volt		277 Volt	
0 – 60 '	12AWG	0 – 175 '	12AWG	0-100 '	12AWG	0 – 200 '	12AWG
60 – 100 '	10AWG	175 - 350'	10AWG	100’ & Up	10AWG	200 ' & Up	10AWG
100' & Up	8AWG	350> & Up	8AWG				

G. Circuit length as given above shall be the wire length between the first and last outlet on the circuit. Home run length as given above shall be the wire length between the first outlet and the panelboard. In accordance with the above, where the size of branch circuit conductors is increased by the minimum required by the NEC for the branch circuit rating, ensure that the termination provisions of all equipment connected to such circuits are listed as suitable for the conductor sizes involved.

H. Joints of 10 AWG and smaller shall be made with properly insulated solderless type pressure connectors. Where stranded conductors or multiple solid conductors are connected to terminals, solderless lugs manufactured by Thomas and Betts Company or equivalent shall be used.

I. Joints of 8 AWG and larger shall be of the type indented into the conductor by means of a hand or hydraulic pressure tool. Connectors shall be Burndy Hy dent, T&B Sta Kon, or equivalent. Connectors for control wiring shall be Burndy Hy Lug, or equivalent.

J. All circuits for underground exterior electric work shall be 10 AWG (minimum) and contain a 10 AWG (minimum) copper grounding conductor. All exterior wiring shall be installed in conduit as specified above, unless otherwise noted on the Drawings.

3.4. MC CABLE APPLICATIONS

A. MC cable shall be permitted only where concealed above accessible ceilings and/or within drywall partitions and in accordance with the requirements of Division 26 Section “Raceways and Boxes”.

B. MC Cable shall be allowed for connections within a room from a junction box to lighting fixtures.

C. Conduit home runs shall be in electrical metallic tubing (EMT).

D. MC cable shall be allowed from a junction box within a room to receptacles in the same

room.

E. MC cable shall not be allowed to cross one room to another room whether the wall between two rooms goes up to slab or not. If the rooms are identified as two separate rooms, MC cable shall not be used between the two rooms.

F. MC cable shall not be used between two receptacles when they are in two separate rooms, on the same wall.

G. Provide anti-short bushings for all MC cable terminations.

H. Cables shall be supported with appropriate hangers; tie wire is not acceptable.

I. MC cable shall not be used to support other cables/wires.

3.5. INSTALLATION

A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's Standard of Installation.

B. Pull Conductors: Use a UL-listed and manufacturer approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceway. Completely and thoroughly swab conduit system before installing conductors.

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

E. Support cables according to Division 26 Section, “Common Work Results for Electrical” and Division 26 Section, “Hangers and Supports”.

F. Seal around cables penetrating fire rated elements according to Division 26 Section, “Electrical Firestopping”.

G. Identify wires and cables according to Division 26 Section, “Electrical Identification”.

H. Conductors installed in parallel shall be of equal lengths.

I. Wiring at Outlets: Install with at least 6 inches (150 mm) of slack conductor at each outlet in accordance with Article 300.14 of the National Electrical Code.

J. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

K. The Contractor shall provide suitable installation equipment to prevent cutting and abrasion

of conductor insulation. The Contractor shall use suitable cable guides, pulleys, and protective sleeving to prevent damage to cable during installation. Ropes used for pulling of wire and cable shall be made of polyethylene or other suitable non-metallic material. Pulling lines shall be attached to cable by means of either woven basket grips or pulling types attached directly to the conductors. Wire pulling lubricants, if used, shall conform to UL requirements applicable to the various insulations and raceway materials. The lubricants shall be certified by the manufacturer to be non-injurious to such insulation and materials.

L. Each cable shall be labeled at terminals and at all accessible points in equipment and in pull boxes. Each wire shall be labeled at both ends. Labels shall be self-sticking wire markers.

M. Riser cables shall have cable supports as required by Code.

N. For rubber and plastic-covered wire and cable, pulling compound Ideal Yellow 77 may be used.

O. Terminal lugs for wires 8 AWG and larger shall be T&B 54,000 Series or Burndy HY-Dent, compression type, unless noted otherwise. One-hole lugs for wires 4/0 AWG and smaller. Two-hole lugs for all wires 250 kcmil AWG and larger.

P. Install wires and cables using braided rope larger than the cable being pulled to keep twists to a minimum.

Q. Provide an insulated green equipment grounding conductor (EGC), sized per NEC, for all feeder and branch circuits, shown or not shown.

R. Multi-wire branch circuits shall not be permitted. Provide a separate insulated neutral (grounded) conductor for all feeder and branch circuits requiring a neutral connection.

S. Install electrical cables, wires, and connectors as indicated in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices.

T. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.

U. Conductors installed in runs within 6 inches of heating pipes or equipment shall be of types required by the NEC and shall be listed for the application.

V. No conductors shall be drawn into conduit until all work, which may cause cable damage, is completed.

W. All wiring in lighting fixture channels, over boilers and breechings, and in other high ambient temperature areas, shall be of types required by NEC and shall be listed for the application.

X. During installation, do not deform cable by improper bending, stretching, twisting, kinking, or pinching, nor do any other abusive handling. Any failure to observe these instructions will be detected and corrected during the demonstrations following completion of the

installation.

Y. All cable runs shall contain S loops or other means to accommodate expansion or contraction as required.

Z. Cable bends will have a radius not less than the value recommended by the cable manufacturer.

AA. All labels shall be of durable material and securely fastened to the cable.

BB. Wiring of different system voltages shall not be mixed at pull boxes enclosures, surface metal raceway, wiretrough, etc., unless a barrier (separator) is provided between the differing systems.

3.6. CONNECTIONS

A. Conductor Splices: Keep to minimum.

B. Install splices and taps that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

C. Use splice and tap connectors compatible with conductor material.

D. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.

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.

F. Wire splices and taps shall be adequate to carry full current rating of wire.

G. Conductors shall be continuous from outlet to outlet, and no splices shall be made except within outlet or junction boxes. Junction boxes may be utilized where required. Wire connectors of insulating material or solderless pressure connections, properly taped, shall be utilized for all splices in wiring.

H. Splices in branch circuits and feeders shall be made where indicated or as required for the installation. All splices shall be accessible and made in enclosure approved for that purpose.

I. For splices in branch circuits and feeders, provide connectors as follows;

1. Wire Sizes 10 AWG and smaller: Provide wire nut connectors as specified in Part 2 of this Section.

2. Wire Sizes 8 AWG and Larger: Provide insulated connectors as specified in Part

2 of this Section.

J. Thoroughly clean wiring prior to installing lugs or connectors.

3.7. IDENTIFICATION

A. All building wire and cable shall be color-coded to identify the electrical system(s) as specified. Where color-coding is field-applied, the same shall be accomplished with colored electrical tape wrapped concentrically around each conductor in half-lapped turns, for at least the last six (6) inches of the conductor. One turn around the conductor is not acceptable.

B. Identify wire and cable using Thomas and Betts Type WM vinyl markers.

C. Identify each phase and neutral conductor with its circuit number or other designation indicated on the Drawings in all junction, pull, terminal boxes, and cabinets.

D. Provide identification tags on each conductor entering each panelboard, switch, junction box, and pull box to identify conductor.

E. Comply with the requirements of Division 26 Section, Electrical Identification.

F. Feeder Identification: Securely fasten nonferrous identifying tags or pressure-sensitive labels to all cables, feeders, and power circuits in pull boxes, handholes, panelboards, and at termination of cables.

1. Tags or labels shall be stamped or printed to correspond with markings on Contract Drawings or marked so that feeder or cable may be readily identified.

3.8. 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 conductors using Manufacturer’s approved methods and materials.

3. Verify that conductors are correct size and are terminated with appropriately sized lugs.

4. Verify that conductors are correct color for phase identification.

5. Verify that conductors are labeled to identify circuit designation.

6. Verify that neutral conductors are only terminated at neutral lugs/bus, and that grounding conductors are only terminated at grounding lugs/bus.

7. Verify that oxide inhibitor is provided at all terminations for aluminum conductors.

B. Electrical Tests: Upon installation of conductors and before electrical circuitry has been energized, provide the following minimum inspections and tests according to

manufacturer's written instructions to ensure conductors are operational within industry and manufacturer's tolerances, are installed according to the Contract Documents, and are suitable for energizing.

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.

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. Verify continuity of each conductor.

5. Insulation Resistance Testing: Perform megohm meter tests of all new service and feeder circuits, including each phase, neutral, and grounding conductor, as follows:

    a. Minimum Test Voltage: 1000 Vdc.
    b. Minimum Insulation Resistance: 1 megohms.
    c. Duration of Each Test: 1 minute.
    d. Temperature Correction: Correct results for test temperature deviation from 20 degrees C standard.
    e. Compare test results with specified performance or manufacturer’s data. Correct deficiencies identified by tests and retest.
    f. 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.

END OF SECTION

DIVISION 26 SECTION 260526
GROUNDING AND BONDING
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SECTION 260526

GROUNDING AND BONDING

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.

B. Refer to Division 26 Section "Conductors and Cables" for conductor and cable requirements.

1.2. SUMMARY

A. This Section includes grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.

B. Bond each separately-derived system neutral to nearest grounding system.

C. Bond together system neutrals; service equipment enclosures; exposed non-current carrying metal parts of electrical equipment; metal raceway systems; grounding conductor in raceways; receptacle ground connectors; and plumbing systems.

1.3. DEFINITIONS

A. EGB: Electrical grounding busbar.

B. EGC: Equipment grounding conductor.

C. GEC: Grounding electrode conductor.

D. SSBJ: Supply-side bonding jumper.

E. TGB: Telecommunications grounding busbar.

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 conductors, connectors and connection materials, and grounding fittings. Submit ground system manufacturer's recommended installation procedure for review.

C. Field tests and observation reports indicating and interpreting the test reports for compliance with performance requirements.

1.5. QUALITY ASSURANCE

A. Comply with NFPA 70 - National Electrical Code.

B. Comply with UL 467 - UL Standard for Safety Grounding and Bonding Equipment.

C. Comply with ANSI/IEEE C2 - National Electrical Safety Code.

D. Comply with ANSI/IEEE 32 - Requirements, terms and test procedures for neutral grounding devices.

E. Comply with IEEE Standard 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

F. Comply with ANSI C33.8.

G. 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.

1.6. PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of grounding electrodes and all primary grounding locations (i.e., grounding busbar location(s), water service connection(s), gas service connection, building steel, etc.)

PART 2. PRODUCTS

2.1. MANUFACTURERS

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

1. Erico Inc.; Electrical Products Group.

2. Harger Lightning and Grounding; Harger, Inc.

3. Heary Brothers Lightning Protection Co.

4. Ideal Industries, Inc.

5. ILSCO.

6. O-Z/Gedney Co.

7. Raco, Inc.

8. Thomas & Betts, Electrical.

2.2. GROUNDING AND BONDING PRODUCTS

A. Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.3. WIRE AND CABLE GROUNDING CONDUCTORS

A. Comply with Division 26, Section "Conductors and Cables". Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.

B. Equipment Grounding Conductors: Size as indicated on the Drawings, or as required by National Electrical Code (NEC) Table 250-122, whichever is larger. Insulated with green color insulation.

C. Grounding Electrode Conductors: Size as indicated on the Drawings, in the Specifications, or as required by National Electrical Code (NEC) Table 250-66, whichever is larger. Insulated with green color insulation, unless installed in direct contact with earth, in which case conductors shall be bare.

D. Bare Copper Conductors: Conform to the following:

1. Solid Conductors: ASTM B 3.

2. Assembly of Stranded Conductors: ASTM B 8.

3. Tinned Conductors: ASTM B 33.

2.4. MISCELLANEOUS CONDUCTORS

A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section, minimum size ¼-inch thick x 4-inches, length as required.

B. Braided Bonding Jumpers: Copper tape, braided bare copper wire, terminated with copper ferrules.

C. Bonding Straps: Soft copper, 0.05 inch (1 mm) thick and 2 inches (50 mm) wide, unless otherwise indicated.

2.5. CONNECTOR PRODUCTS

A. Mechanical Connectors

1. The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of silicon bronze and supplied as a part of the connector body and shall be of the two-bolt type.

2. Split bolt connector types are NOT allowed unless indicated on the Drawings.

3. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

B. Compression Connectors

1. The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99 percent by IACS Standards.

2. The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.

3. The installation of the connectors shall be made with a compression, tool and die system, as recommended by the manufacturer of the connectors.

4. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.

5. Each connector shall be factory filled with an oxide-inhibiting compound.

2.6. GROUNDING ELECTRODES

A. Grounding Rods: Copper-clad rod with rigid steel core.

1. Size: 3/4 inch by 120 inches (19 by 3000 mm). Provide the number of rods required to obtain proper ground resistance.

2. Rods shall have a minimum of ten (10) mils of copper.

3. Ground rods shall be UL listed #467.

PART 3. EXECUTION

3.1. APPLICATION

A. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.

1. Install Equipment Grounding Conductor (EGC) with circuit conductors for the items below in addition to those required by Code:

a. Feeder circuits.
b. Lighting branch circuits.
c. Receptacle branch circuits.
d. Single-phase motor or appliance branch circuits.
e. Three-phase motor or appliance branch circuits.
f. Flexible raceway runs.
g. Metal-clad (MC) cable runs.

2. Water Heater Circuits: Install a separate equipment grounding conductor to each electric water heater. Bond conductor to heater units, piping, connected equipment, and components.

B. Telecommunications System Grounding:

1. Refer to technology drawings.

C. Mechanical System Grounding:

1. All mechanical equipment, including but not limited to pumps, motors, packaged equipment, fans, heaters, etc. and their enclosures shall be properly grounded in accordance with Article 250 of the National Electrical Code.

2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

D. Separately Derived Systems: Ground and bond all separately derived systems in accordance with Article 250.30 of the National Electrical Code, and as follows:

1. Transformers:

a. Provide a grounding electrode conductor from the transformer to the nearest grounding electrode, e.g. building steel. Where the grounding electrode conductor is installed within metallic raceway, both ends of the raceway shall be also be bonded.
b. Provide a system bonding jumper from the transformer neutral point to the transformer enclosure. The system bonding jumper must remain within the enclosure where it originates.
c. Provide a supply-side bonding jumper from the transformer neutral point to the ground bus bar in the first disconnecting means or overcurrent device, e.g. panelboard.

2. Metal Water Pipe:

a. All metal water piping in the area served by the separately derived system shall be bonded to the neutral point of the separately derived system with a bonding jumper in accordance with Article 250.104 of the National Electrical Code.
b. Metal water piping is permitted to be bonded to the structural metal building frame in lieu of the neutral point of the separately derived system, if the structural metal serves as the grounding electrode for the separately derived system.

3. Structural Metal:

a. Exposed structural metal in the area served by the separately derived system shall be bonded to the neutral point of the separately derived system with a bonding jumper in accordance with Article 250.104 of the National Electrical Code.
b. A separate bonding jumper to structural metal is not required where the structural metal serves as the grounding electrode for the separately derived system.

4. Grounding and bonding conductors and jumpers shall be sized in accordance with Table 250.66, Table 250.122 and Article 250.102 of the National Electrical Code.

E. Metal Poles Supporting Outdoor Lighting Fixtures: Ground pole to a grounding electrode in addition to separate equipment grounding conductor run with supply branch circuit.

3.2. INSTALLATION

A. General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.

B. Grounding Bus Bars: Space 1 inch (25 mm) from wall and support from wall 6 inches (150 mm) above finished floor, except as otherwise indicated.

C. Grounding Electrodes: Provide grounding electrodes, unless in accordance with the following:

1. Locate a minimum of twenty-feet from each other and at least the same distance from any other grounding electrode, unless otherwise indicated on the Drawings.

2. Drive until tops are 24 inches below finished floor or final grade, except as otherwise indicated.

3. Interconnect with grounding-electrode conductors using exothermic welds, unless otherwise indicated. Make these connections without damaging copper coating or exposing steel.

D. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

E. Underground Grounding Conductors: Use bare copper wire. Bury at least 24 inches (600 mm) below grade.

F. Metal Water Service Pipe: Provide insulated copper grounding conductors, sized as indicated, 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 by grounding-clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Do not install a grounding jumper across dielectric fittings. Bond grounding-conductor conduit to conductor at each end.

G. Grounding shall satisfy requirements of the applicable publications. All exposed noncurrent-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in nonmetallic raceways, and grounded conductors of the wiring system shall be grounded.

H. The grounded conductor (neutral) of the wiring system shall be connected to the system grounding conductor at a single place in the system by removable bonding jumpers, sized according to the applicable provisions of the National Electrical Code. The grounded conductor (neutral) connection to the grounding conductor (ground) shall be located in the enclosure for the system's overcurrent protection or where otherwise indicated on the Drawings or Specifications.

I. Ground buses and neutral buses in all distribution panelboards, branch panelboards, and those provided in any equipment shall be isolated except where required to be connected as specified above for the service entrance and in transformer terminal compartments.

J. Equipment grounding conductors shall be extended from the ground bus in the distribution equipment to the receptacle, fixture or device lugs where they are provided. When not provided, they shall be connected to equipment enclosures. The connections shall be arranged such that removal of receptacle, the equipment grounding conductors, or ground jumpers from ground busing, shall not affect the system ground.

K. Ground bus shall be provided as indicated on the Drawings or as necessary to provide termination for equipment grounding conductor. Non-current carrying metal parts of electric equipment shall be effectively grounded by bonding to the bus.

L. Raceways shall not be considered as a grounding conductor. Each power, lighting, or control raceway shall have a separate equipment grounding conductor installed. Receptacles shall have a separate grounding pole.

3.3. CONNECTIONS

A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure 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.

B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor (EGC) Terminations: For 8 AWG and larger, use compression-type grounding lugs. 10 AWG and smaller grounding conductors may be terminated with wire nut connectors as specified in Division 26 Section, “Conductors and Cables”.

D. Non-Contact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at both

entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

END OF SECTION

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ELECTRICAL FIRESTOPPING
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SECTION 26 05 28

ELECTRICAL FIRESTOPPING

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. Through-penetration firestopping in fire rated construction.

B. Related items: Raceway seals and manufactured electrical devices: Refer to Division 26 Section, “Raceways and Boxes”.

1.3. REFERENCES

A. Underwriters Laboratories

1. UL Fire Resistance Directory

a. Through-penetration firestop devices (XHCR)
b. Fire resistance rating (BXUV)
c. Through-penetration firestop systems (XHEZ)
d. Fill, void, or cavity material (XHHW)

B. American Society for Testing and Materials Standards: ASTM E 814-88: Standard Test Method for Fire Tests of Through-Penetration Firestops.

1.4. DEFINITIONS

A. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.

B. Barriers: Time-rated fire walls, time rated ceiling/floor assemblies and structural floors.

C. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gasses and smoke.

D. Penetration: Opening or foreign material passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.

E. System: Specific products and applications classified and numbered by Underwriters Laboratories, Inc. to close specific barrier penetrations.

F. Sleeve: Metal fabrication or pipe section extended through thickness of barrier and used to permanently guard penetration. Refer to Division 26 Section, “Common Work Results

for Electrical" for sleeve requirements.

1.5. SYSTEM DESCRIPTION

A. Design Requirements

1. Fire-rated construction: Maintain barrier and structural floor fire resistance ratings including resistance to cold smoke at all penetrations, connections with other surfaces or types of construction, at separations required to permit building movement and sound or vibration absorption.

1.6. SUBMITTALS

A. Submit in accordance with Division 01, unless otherwise indicated.

B. Product Data: Manufacturer's specifications and technical data including the following:

1. Detailed specification of construction and fabrication.

2. Manufacturer's installation instructions.

1.7. QUALITY ASSURANCE

A. Installer's qualifications: Firm experienced in installation or application of systems similar in complexity to those required for this project, plus the following:

1. Acceptable to or licensed by manufacturer, State or local authority where applicable.

2. At least 2 years experience with systems.

3. Successfully completed at least 5 comparable scale projects using this system.

B. Local and State regulatory requirements: Submit forms or acceptance for proposed assemblies not conforming to specific UL Firestop System numbers, or UL classified devices.

C. Materials shall have been tested to provide fire rating at least equal to that of the construction.

D. Manufacturer shall be a member of the International Firestop Council (IFC).

1.8. DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:

1. Deliver products in original unopened packaging with legible manufacturer's identification.

2. Coordinate delivery with scheduled installation date, allow minimum storage at site.

B. Storage and protection: Store materials in a clean, dry, ventilated location. Protect from soiling, abuse, moisture and freezing when required. Follow manufacturer's instructions.

1.9. PROJECT CONDITIONS

A. Existing conditions:

1. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

2. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.

B. Environmental requirements:

1. Furnish adequate ventilation if using solvent.

2. Furnish forced air ventilation during installation if required by manufacturer.

3. Keep flammable materials away from sparks or flame.

4. Provide masking and drop cloths to prevent contamination of adjacent surfaces by firestopping materials.

1.10. GUARANTEE

A. Submit copies of written guarantee agreeing to repair or replace joint sealers which fall in joint adhesion, extrusion resistance, migration resistance, or general durability or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated. The guarantee period shall be two years from date of substantial completion unless otherwise noted.

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:

1. Hilti

2. 3M

3. Nelson

2.2. THROUGH-PENETRATION FIRESTOPPING OF FIRE-RATED CONSTRUCTION

A. Systems of devices listed in the UL Fire Resistance Directory under categories XHCR and XHEZ may be used, providing that it conforms to the construction type, penetrate type, annular space requirements and fire rating involved in each separate instance, and that the system be symmetrical for wall applications. Systems or devices must be asbestos-free.

1. Additional requirements: Withstand the passage of cold smoke either as an inherent property of the system, or by the use of a separate product included as a part of the UL system or device, and designed to perform this function.

2. Acceptable manufacturers and products.

   a. Those listed in the UL Fire Resistance directory for the UL System involved and as further defined in the "System and Applications Schedule" in Part 3 of this Section.
   b. All firestopping products must be from a single manufacturer.

2.3. ACCESSORIES

A. Fill, void or cavity materials: As classified under category XHHW in the UL Fire Resistance Directory.

B. Forming materials: As classified under category XHKU in the UL Fire Resistance Directory.

C. Sleeves: Minimum 24 MSG galvanized steel, 12-inch diameter or smaller steel pipe. Sleeve shall project ½-inch from each surface of the floor/wall. Size as recommended by firestop manufacturer.

PART 3. EXECUTION

3.1. EXAMINATION

A. Verification of conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

1. Verify barrier penetrations are properly sized and in suitable condition for application of materials.

2. Do not proceed until unsatisfactory conditions have been corrected.

3.2. PREPARATION

A. Clean surfaces to be in contact with penetration seal materials of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.

3.3. INSTALLATION

A. Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and in accordance with manufacturer's instruction.

B. Seal holes or voids made by penetrations to ensure an effective barrier.

C. Protect materials from damage on surfaces subject to traffic.

D. When large openings are created in walls or floors to permit installation of conduits, cable tray, or other items, close unused portions of opening with firestopping materials tested for

the application.

E. Provide sleeves the full thickness of the assembly being penetrated and cut sleeves to a length of 1-inch more than the overall thickness of the penetration, or as recommended by the firestop manufacturer.

3.4. FIELD QUALITY CONTROL

A. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Perform under this section patching and repairing of firestopping caused by cutting or penetration by other trades.

3.5. ADJUSTING AND CLEANING

A. Clean up spills of liquid components.

B. Neatly cut and trim materials as required.

C. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

3.6. SYSTEMS AND APPLICATION SCHEDULES*

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
Metal Pipe	CAJ1001 CP25S/L, CP25N/S CAJ1006 CS-195+, FS-195+ CAJ1007 FS-195+, 1-inch& 2-inch Wide CAJ1009 2000, 2000+, 2003 CAJ1010 2000, 2000+, 2003 CAJ1012 2000, 2000+, 2003 CAJ1013 2000, 2000+, 2003 CAJ1014 2000, 2000+, 2003 CAJ1015 2000, 2000+, 2003 CAJ1017 FD 150 CAJ1021 FD 150 CAJ1027 MPS-2+ CAJ1044 CP 25WB+ CAJ1052 CP 25S/L, CP 25N/S CAJ1058 2000, 2000+, 2003 CAJ1060 2000, 2000+, 2003 CAJ1063 2000, 2000+, 2003 CAJ1066 CP 25N/S,CP 25S/L, CP 25WB+ CAJ1091 CP 25N/S,CP 25S/L, CP 25WB+ CAJ1092 CP 25WB+ CAJ1112 FS-195+ CAJ1160 CP 25S/L, CP 25N/S CAJ1175 CP 25WB+ CAJ1176 CP 25WB+ CAJ1188 2000+ CBJ1020 CS-195+, FS-195+	WL1001 CP 25 WL1002 FS-195+ WL1003 CP 25WB+,CP 25N/S WL1008 2000+ WL1009 2000+ WL1010 2000+ WL1016 CP 25WB+ WL1017 CP 25WB+,CP 25N/S WL1032 CP 25WB+,CP 25N/S WL1036 FD 150 WL1037 CS-195+,FS-195+ WL1067 CP 25N/S WL1073 CP 25WB+ WL1080 MPS-2+ WL1082 2000+	FC1002 CP 25 FC1003 2000,2000+,20003 FC1006 CP 25WB+

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
	CBJ1021 CS-195+, MPS-2+ CBJ1031 2001 CBJ1032 2001 FA1002 CP 25WB+ WJ1010 CP 25WB+ WJ1023 2001		
Non-Metallic	CAJ2001 FS-195+, 1-inch& 2-inch WIDE, PPD'S CAJ2002 FS-195+ CAJ2003 CS-195+, FS-195+ CAJ2005 FS-195+ CAJ2006 FS-195+ CAJ2013 FS-195+ CAJ2019 2000, 2000+, 2003 CAJ2027 FS-195+, CP 25N/S, CP 25S/L, CP 25WB+ CAJ2028 FS-195, MPS-2+ CAJ2029 FS-195+, PPD'S CAJ2030 CS-195+, FS-195+ CAJ2040 FS-195+, CP 25WB+ CAJ2044 FS-195+, CP 25N/S, CP 25S/L CP 25 WB+ CAJ2090 FS-195+ CAJ2177 FS-195+, PPD'S FA2001 FS-195+, PPD'S FS2002 CS-195+, FS-195+, MPS-2+, PPD'S FA2011 FS-195+ WJ2012 FS-195+ 1-inch WIDE	WL2002 FS-195+, PPD'S WL2003 FS-195+ WL2004 FS-195+ WL2005 FS-195+ 4' WIDE WL2006 FS-195+ WL2013 FS-195+ WL2031 CS-195+, FS-195+ WL2032 CS-195+, FS-195+ WL2033 FS-195+ WL2073 FS-195+ 1-inch WIDE	FC2002 FS-195+, PPD'S FC2007 FS-195+, PPD'S FC2008 FS-195+ FC2009 FS-195+, PPD'S FC2024 FS-195+ FC2026 FS-195+ FC2028 FS-195+, 1' & 2-inch WIDE, PPD'S
Insulated Cable	CAJ3001 CP 25N/S, CP 25S/L CAJ3005 CS 195+, FS-195+ CAJ3007 2001 CAJ3009 2000, 2000+, 2003 CAJ3010 2000, 2000+, 2003 CAJ3011 2001 CAJ3014 FD 150 CAJ3015 FD 150 CAJ3021 MPS-2+ CAJ3029 2000, 2000+, 2003 CAJ3030 CP 25WB+ CAJ3031 CP 25N/S, CP 25S/L CAJ3041 2000, 2000+, 2003 CAJ3044 CS-195+, FS-195+ CAJ3058 FS-195+, MPS-2+ CAJ3071 CP 25N/S, CP 25S/L CAJ3074 CP 25N/S, CP 25S/L CAJ3075 2001 CAJ3080 CP 25WB+ CBJ3016 CS-195+, FS-195+ CBJ3017 CS-195+, MPS-2+ FA3001 CP 25WB+ FB3004 CS-195+, MP WJ3015 2001 WJ3016 2001	WL3001 CP 25, MPS-2+ WL3008 2000+ WL3009 2000+ WL3015 CP 25WB+, CP 25N/S WL3022 2000+ WL3030 FS-195+ WL3031 MPS-2+ WL3032 CP 25WB+ WL3041 2000+ WL3051 CP 25N/S WL3056 CP25N/S WL3062 CP 25WB+	FC3001 CP 25S/L, CP 25N/S FC3002 2000+ FC3003 2000, 2000+, 20003 FC3007 CP 25WB+, MPS-2+ FC3008 FS-195+
Mixed Penetrating Items	CAJ8001 CS-195+ FS-195+ CAJ8003 2000, 2000+, 20003 CAJ8004 2000, 2000+, 20003	WL8002 CS-195+, FS-195+	

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
Combos	CAJ8006 2001 CAJ8013 FS-195+, CP 25 CBJ8004 CS-195, FS-195+ CBJ8005 CS-195+, MPS-2+ CBJ8008 2001 FA8001 FS-195+, CP 25WB+		

*Underwriter's Laboratories, Inc., Fire Resistance Directory.

END OF SECTION

DIVISION 26 SECTION 26 05 29
HANGERS AND SUPPORTS
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HANGERS AND SUPPORTS

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.

B. Requirements of the following Sections apply to this Section:

1. Division 26 Section, "Common Work Results for Electrical" for general installation requirements.

1.2. SUMMARY

A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

B. Provide equipment supports consisting of concrete pads, structural members, hangers, rods, racks, and incidental materials.

C. Provide all labor, supervision, and fabrication. Design and construct supporting structures of strength to safely withstand stresses to which they may be subjected and to properly distribute the load and impact over building areas. Provide all engineering and fabrication as required for installation of support system.

D. Provide hangers, clamps, anchors, inserts, supports, supplementary steel framing, and hardware of the proper size and load capacity to support electrical equipment and raceways, whether indicated on the drawings or not.

1.3. SUBMITTALS

A. General: Submit the following in accordance with conditions of Contract and Division 01 Specification Sections.

B. Product data for each type of product specified.

C. Supporting devices and fastening methods shall be subject to the review and approval of the Structural Engineer.

1.4. QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 National Electrical Code.

B. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party Certification follow-up services.

C. Installation Standard: Installation shall meet or exceed the National Electrical Contractors Association (NECA) Standard of Installation.

D. Manufacturer's Qualifications:

1. The Manufacturer shall not have had less than ten years' experience in manufacturing Strut Support Systems.

2. The Manufacturer must certify in writing all components supplied have been produced in accordance with an established quality assurance program.

E. Standards:

1. Work shall meet the requirements of the following standards:

a. Federal, State and Local Codes.
b. American Iron and Steel Institute (AISI) Specification for the Design of Cold-Formed Steel Structural Members.
c. American Society for Testing and Materials (ASTM).
d. Underwriters Laboratories (UL).
e. National Electrical Code (NEC).

1.5. PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All material is to be delivered to the work site in original factory packaging to avoid damage to the finish.

B. Upon delivery to the work site, all components shall be protected from the elements by a shelter or other covering.

1.6. GUARANTEE

A. Separate guarantees shall be issued from the erector and manufacturer, valid for a period of one year against any defects that may arise from the installation or manufacture of the Strut Support System components.

PART 2. PRODUCTS

2.1. MANUFACTURERS

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

1. Slotted Metal Angle and U-Channel Systems:

a. American Electric, Kindorf
b. Alstrut
c. Unistrut Diversified Products
d. Power-Strut
e. Thomas & Betts

2.2. COATINGS

A. Dry, Interior Locations: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion-resistance using approved alternative treatment, finish, or inherent material characteristic. All products installed in dry interior locations shall be hot-dip galvanized, unless otherwise noted.

B. Damp or Wet Locations: Supports, support hardware, and fasteners installed in damp or wet locations, including exterior locations, shall be Type 304 stainless steel.

2.3. MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Fasteners: Types, materials, and construction features, as follows:

1. Expansion Anchors - Carbon steel wedge or sleeve type.

2. Toggle Bolts - All steel springhead type.

3. Power-Driven Threaded Studs - Heat-treated steel, designed specifically for the intended application.

C. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

D. U-Channel Systems: Sixteen-gauge channels with 9/16-inch-diameter slotted holes at a minimum of two inches on center in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer.

E. Concrete Equipment Pads:

1. Refer to Division 26 Section “Common Work Results for Electrical” for installation requirements.

F. Ceiling Suspended Platforms: Construct with steel hangers. Brace and fasten to building structure.

G. Wall-Mounted Platforms: Construct with steel brackets.

2.4. ANCHOR METHODS

A. Hollow Masonry: Toggle bolts or plastic conical type expansion anchors.

B. Solid Masonry: Lead expansion anchors or preset inserts.

C. Metal Surfaces: Machine screws, bolts, or welded studs.

D. Wood Surfaces: Wood screws.

E. Concrete Surfaces: Self-drilling anchors or power-driven studs.

PART 3. EXECUTION

3.1. EXAMINATION

A. The installer shall inspect the work area prior to installation. If work area conditions are unsatisfactory, installation shall not proceed until satisfactory corrections are completed.

3.2. INSTALLATION

A. Set Strut System components into final position true to line, level and plumb, in accordance with approved Shop Drawings.

B. Anchor material firmly in place. Tighten all connections to their recommended torques.

C. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

D. Coordinate with the building structural system and with other electrical installation.

E. Raceway Supports: Comply with the NEC and the following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.

2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 pounds, provide additional strength until there is a minimum of 200 pounds safety allowance in the strength of each support.

3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

4. Support parallel runs of horizontal raceways together on trapeze-type hangers.

5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.

6. Space supports for raceways in accordance with Table I of this Section. Space supports for raceway types not covered by the above in accordance with NEC.

7. Support exposed and concealed raceway within one foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminations are not made with chase nipples or threadless box connectors.

8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminations.

F. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting disconnects, light fixtures, and other devices.

G. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to the raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.

H. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including, but not limited to conduits, raceways, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures.

2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4-inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.

3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration-and shock-resistant fasteners for attachments to concrete slabs.

4. Concrete (New): Iron or steel inserts. Expander type anchors, specified for existing may be used provided concrete is clear of conduit for drilled depth.

5. Concrete (Existing): Double-plated expander type anchors. Phillips, Hilti, or approved equivalent. Loads shall not exceed 1/4 of tested pullout (or shear) strength.

I. General Supporting Installations:

1. Provide appropriate concrete anchors for hanger rods. Rods shall be screwed into or extended through frame construction (with washer and nut). Supports shall secure conduit in place, and shall prevent vibration, provide for expansion and contraction and shall make neat appearance. Strap hangers or chains are not permitted.

2. Electrical raceways 1-1/2-inches and smaller shall be secured with 1-hole malleable iron straps or brackets to walls. Trapeze supports shall be used for

groups or parallel raceways with raceways secured to trapeze with approved clamps. Individual runs of raceways 2-inches and larger shall be supported by Clevis type hangers.

3. Provide all steel supports including roof curbs for all equipment provided under this Section.

4. Electrical raceway supports to be spaced on the following maximum centers, unless otherwise required by the NEC:

   a. 3/4-inch to 1-inch conduit - 8 feet
   b. 1-1/4-inch and larger conduit - 10 feet

J. Provide additional hangers or steel members to distribute the load among two or more structural members when required or directed.

K. Locations:

1. Anchor bolts, sleeves, inserts, hangers, and supports required for the electrical work shall be furnished and installed under Division 26.

2. Coordinate with other trades the location of anchors, sleeves, inserts, and supports and insure that they are properly installed.

3. Openings and sleeves shall be set true to line, level, plumb, and position and shall be set true to line, level, plumb, and position and shall be so maintained during construction. Where sleeves and openings are provided in poured concrete, inspect same during and after concrete is poured to insure proper position and correct any deviation.

L. Hangers and Supports:

1. Provide hangers, angles, channels, and other supports required by field conditions to install items of electrical equipment. Design of supports and methods of fastening to building structure shall be acceptable to the Owner.

2. Use of power-actuated fasteners and devices is permitted in the vertical surfaces of the building only with the following requirements.

   a. For fastening conduits 1-1/2-inch and smaller and lighting fixtures 50 lbs or less.
   b. Load capacity per manufacturers' recommendations.
   c. Fasteners shall be located in the thickest part of the slab.
   d. Devices shall comply with OSHA requirements.

3. Use of lead shield expansion anchors is not permitted.

4. No electrical items shall rest on, or depend for support on suspended ceiling media (tiles, lath, plaster, splines, etc.).

5. In spaces with suspended ceilings, support conduits directly from structural slabs,

decks (or framing members). Do not support conduits on ceiling suspension members.

6. Support surface or pendant lighting fixtures:

   a. From an outlet box by means of an interposed metal strap, where weight is less than 5 lbs.
   b. From an outlet box by means of a hickey or other direct threaded connection, where weight is from 5 to 50 lbs.
   c. Directly from structural slab, deck or framing member, where weight exceeds 50 lbs.

7. In addition to the above, provide cushioned, swivel type hangers with appropriate outlet boxes for pendant fixtures in mechanical areas. Such hangers shall have a support rating at least twice that of the load supported.

8. Support recessed lighting fixtures directly from structural slab, deck, or framing members. Refer to Division 26 Section "Interior Lighting" for additional installation requirements.

9. Provide weight-distribution facilities, where required so as not to exceed the load bearing capabilities of floor or walls that bear the weight of, or support, electrical items.

10. For point-of-attachment weight of 100 lbs. or less, fasten items as follows:

    a. On wood, use wood screws.
    b. On concrete and solid masonry that is already in place, use self-drilling concrete anchors or expansion bolt and couplings.
    c. On hollow construction, use toggle bolts.
    d. On structural steel, use beam clamps.

11. For point-of-attachment weights from 100 lbs. to 300 lbs., provide supports as follows:

    a. At cast-in-place concrete slabs, use concrete inserts in bottom of slab, with 8" slip-through steel rods set transverse to the reinforcing steel.
    b. At concrete slab already in place, uses 16-inches x 8-inches x ½-inch steel plates at the top of the slab, with through-bolts welded in place. The plates shall be chased in and grouted flush, where no fill is to be applied.

12. For point-of-attachment weights over 300 lbs., provide supports as follows: At cast-in-place concrete slabs, uses 16-inch x 8-inch x ½-inch steel plate, with through bolts welded in place. Top of the plate shall be 1-1/2-inches below the top of the slab or on top of the slab where a fill slab is to be installed.

13. Equipment shall not be held in place by its own dead weight. Provide base anchor fasteners in each case.

14. Trapeze type hangers may be used where several conduits are to be installed at the same elevation. The spacing of such trapeze hangers shall be in accordance with

the NEC for the smallest conduit in the run.

15. Vertical conduits shall be supported by heavy wrought iron clamps or collars anchored to construction at each floor.

M. Inserts:

1. Inserts for suspended items in poured concrete construction shall be malleable-iron concrete inserts, adjustable type with insert nut. Items manufactured by Barrett, Crawford, Elcen, or Grinnell shall be used where applicable.

2. Inserts for surface-mounted items shall be suitable for the composition of the slab, wall, or structure on which installation is to be made.

N. TABLE I: SPACING FOR RACEWAY SUPPORTS

TABLE I: SPACING FOR RACEWAY SUPPORTS				
Raceway Size (Inches)	No. of Conductors in Run	Location	PVC & RGS (Ft.)	EMT (Ft.)
		HORIZONTAL RUNS		
1/2, 3/4	1 or 2	Flat ceiling or wall.	5	5
1/2, 3/4	1 or 2	Where it is difficult to provide supports except at intervals fixed by the building construction.	7	7
1/2, 3/4	3 or more	Any location.	7	7
1/2 - 1	3 or more	Any location.		
1 & larger	1 or 2	Flat ceiling or wall.	6	6
1 & larger	1 or more	Where it is difficult to provide supports except at intervals fixed by the building construction.	10	10
1 & larger	3 or more	Any location.	10	10
Any	---	Concealed.	10	10
		VERTICAL RUNS		
1/2, 3/4	---	Exposed.	7	7

1, 1-1/4	---	Exposed.	8	8
1-1/2 & larger	---	Exposed.	10	10
Up to 2	---	Shaftway.	14	10
2-1/2	---	Shaftway.	16	10
3 & larger	---	Shaftway.	20	10
Any	---	Concealed.	10	10
Abbreviations:	EMT	Electrical Metallic Tubing		
	PVC	Rigid Polyvinyl Chloride Conduit		
	RGS	Rigid Galvanized Steel Conduit		

3.3. CLEANUP

A. Upon completion of this Section of work, remove all protective wraps and debris. Repair any damage due to installation of this section of work.

3.4. PROTECTION

A. During installation, protect this work from damage.

B. Upon completion of this scope of work, it shall become the responsibility of the General Contractor to protect this work from damage during the remainder of construction on the project and until substantial completion.

END OF SECTION

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RACEWAYS AND BOXES
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RACEWAYS AND BOXES

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.

B. Related Sections include the following:

1. Division 26 Section "Conductors and Cables" for conductors installed in raceways and boxes and conductor terminations.

2. Division 26 Section "Electrical Firestopping" for requirements for firestopping at penetrations through walls and floors that are fire barriers.

3. Division 26 Section "Hangers and Supports" for raceways and box supports.

4. Division 26 Section, "Surface Metal Raceway" for surface raceways, fittings, and accessories.

5. Division 26 Section "Underground Ductbanks" for raceways installed in ductbanks and for ductbanks accessories.

6. Division 26 Section "Wiring Devices" for devices installed in boxes.

7. Division 26 Section, "Miscellaneous Raceway Systems" for raceways and box requirements for communications devices and cabling.

1.2. SUMMARY

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

1. Raceways include the following:

a. EMT
b. FMC
c. LFMC
d. LFNC
e. PVC
f. RGS
g. RMC
h. RNC
i. Wireways

2. Boxes, enclosures, and cabinets include the following:

a. Device boxes

b. Outlet boxes
c. Pull and junction boxes
d. Audio/Video wall and/or ceiling boxes
e. Cabinets and hinged cover enclosures

3. Miscellaneous Products include the following:

a. Expansion/Deflection fittings
b. Bushings

1.3. DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FMC: Flexible Metal Conduit.

C. LFMC: Liquidtight Flexible Metal Conduit.

D. LFNC: Liquidtight Flexible Nonmetallic Conduit.

E. PVC: Rigid Polyvinyl Chloride Conduit.

F. RGS: Rigid Galvanized Steel Conduit.

G. RMC: Rigid Metal Conduit.

H. RNC: Rigid Nonmetallic Conduit.

1.4. SUBMITTALS

A. Product Data: For raceways, wireways and fittings, hinged cover enclosures, and cabinets.

B. Shop Drawings: Include layout drawings showing components and wiring for nonstandard boxes, enclosures, and cabinets.

1.5. QUALITY ASSURANCE

A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

B. Comply with NECA's "Standard of Installation" and NECA 101 “Recommended Practice for Installing Steel Conduits”.

C. Comply with NFPA 70.

1.6. COORDINATION

A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

B. Verify routing and termination locations of conduits and boxes prior to rough-in.

C. Conduit routing shown on Drawings is only approximate and diagrammatic. Route conduits as required for a complete conduit and wiring system.

D. Coordinate final locations, mounting heights, and orientation of all outlet, junction, and pull boxes.

E. Coordinate mounting heights and locations of outlet boxes thoroughly with approved casework shop drawings.

1.7. PROJECT RECORD DOCUMENTS:

A. Accurately record routing of all concealed conduits. Record actual routing of all exposed conduits/larger than 1 inch. Indicate actual locations and mounting heights of outlet boxes, pull and junction boxes, branch circuits, arrangements, etc.

PART 2. PRODUCTS

2.1. MANUFACTURERS

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

1. Metal Conduit and Tubing:

   a. Allied Tube & Conduit Corporation.
   b. Anamet, Inc.; Anaconda Metal Hose.
   c. AFC/Monogram Company.
   d. Carol Cable Co., Inc.
   e. Cole Flex Corp.
   f. Electri Flex Co.
   g. Flexcon, Inc.; Coleman Cable Systems, Inc.
   h. Grinnell Co.; Allied Tube and Conduit Div.
   i. Monogram Co.; AFC.
   j. Spiraduct, Inc.
   k. Triangle PWC, Inc.
   l. Wheatland Tube Corporation

2. Nonmetallic Conduit and Tubing:

   a. Anamet, Inc.; Anaconda Metal Hose.
   b. Arnco Corp.
   c. Breeze Illinois, Inc.
   d. Cantex Industries; Harsco Corp.
   e. Certainteed Corp.; Pipe & Plastics Group.
   f. Cole Flex Corp.

g. Condux International; Electrical Products.
h. Electri Flex Co.
i. George Ingraham Corp.
j. Hubbell, Inc.; Raco, Inc.
k. Lamson & Sessions; Carlon Electrical Products.
l. R&G Sloan Manufacturing Co., Inc.
m. Spiraduct, Inc.
n. Thomas & Betts Corporation

3. Conduit Bodies and Fittings:

a. American Electric; Construction Materials Group.
b. Crouse Hinds; Div. of Cooper Industries.
c. Emerson Electric Co.; Appleton Electric Co.
d. Hubbell, Inc.; Killark Electric Manufacturing Co.
e. Lamson & Sessions; Carlon Electrical Products.
f. Z/Gedney; Unit of General Signal.
g. Scott Fetzer Co.; Adalet PLM.
h. Spring City Electrical Manufacturing Co.
i. Thomas & Betts Corporation.

4. Metal Wireways:

a. Hoffman Engineering Co.
b. Keystone/Rees, Inc.
c. Square D Co.

5. Nonmetallic Wireways:

a. Hoffman Engineering Co.
b. Lamson & Sessions; Carlon Electrical Products.
c. Wiremold Co.
d. Hubbell

6. Boxes, Enclosures, and Cabinets:

a. American Electric; FL Industries.
b. Butler Manufacturing Co.; Walker Division.
c. Crouse Hinds; Div. of Cooper Industries.
d. Electric Panelboard Co., Inc.
e. Erickson Electrical Equipment Co.
f. Hoffman Engineering Co.; Federal Hoffman, Inc.
g. Hubbell Inc.; Killark Electric Manufacturing Co.
h. Hubbell Inc.; Raco, Inc.
i. Lamson & Sessions; Carlon Electrical Products.
j. Z/Gedney; Unit of General Signal.
k. Parker Electrical Manufacturing Co.
l. Robroy Industries, Inc.; Electrical Division.
m. Scott Fetzer Co.; Adalet PLM.
n. Spring City Electrical Manufacturing Co.
o. Thomas & Betts Corp.

p. Woodhead Industries, Inc.; Daniel Woodhead Co.

7. Audio/Video Wall/Ceiling Boxes:

a. FSR, Inc.
b. Hubbell, Inc.
c. Legrand/Wiremold

2.2. METAL CONDUIT AND TUBING

A. EMT and Fittings: Hot galvanized steel O.D. with an organic corrosion-resistant I.D. coating. Listed to UL Safety Standard 797 and manufactured in accordance with ANSI C80.3.

1. Fittings: Compression type, NEMA FB1.

B. FMC: Zinc coated steel.

C. LFMC: Flexible steel conduit with PVC jacket.

D. RGS: ANSI C80.1 and UL 6.

E. Plastic Coated Steel Conduit and Fittings: NEMA RN 1.

F. Fittings: NEMA FB 1; compatible with conduit/tubing materials.

2.3. COLORED METAL CONDUIT AND TUBING

A. EMT: Hot galvanized steel O.D. with vibrant color top coat and an organic corrosion-resistant I.D. coating. Listed to UL Safety Standard 797 and manufactured in accordance with ANSI C80.3.

B. Provide True Color® EMT as manufactured by Allied Tube and Conduit, or approved equal by listed manufacturer.

2.4. NONMETALLIC CONDUIT AND TUBING

A. PVC: NEMA TC 2, UL 651, Schedule 40 or 80.

B. PVC Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.

C. LFNC: UL 1660.

2.5. METAL WIREWAYS

A. Material: Sheet metal sized and shaped as indicated.

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

C. Select features, unless otherwise indicated, as required to complete wiring system and to

comply with NFPA 70.

D. Wireway Covers: Screw cover type.

E. Finish:

1. Dry Interior Locations: Manufacturer's standard enamel or galvanized finish, NEMA 1.

2. Damp/Wet Locations: ANSI 49 gray polyester over phosphatized steel, NEMA 3R.

2.6. OUTLET AND DEVICE BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized flat-rolled sheet steel.

B. Cast Metal Boxes: NEMA FB 1, Type FD, cast box, deep type, with gasketed cover, and threaded hubs.

C. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including corrosion-resistant screws, mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps, and metal straps for supporting outlet boxes which are compatible with outlet boxes being used and fulfilling requirements of individual wiring situations.

D. Nonmetallic: NEMA OS2.

2.7. PULL AND JUNCTION BOXES

A. Small Sheet Metal Boxes: NEMA OS 1, galvanized flat-rolled sheet steel.

B. Sheet metal boxes over 12" in any dimension shall comply with the requirements of Article "Enclosures and Cabinets" of this Section.

C. Boxes for Outdoor and Wet Locations: Flat flanged, surface-mounted, UL listed as raintight, galvanized cast iron box and cover with neoprene gasket and stainless steel cover screws.

D. Boxes for Buried Flush Grade Locations: Refer to Division 26 Section, “Utility Holes” for product requirements.

2.8. BOX EXTENSIONS

A. Prohibited on new construction.

B. Where more than one box is needed to flush out installation, provide a large (i.e., 6" x 6") box to flush out the existing box and nipple over to a new box.

2.9. BUSHINGS

A. Bushings shall be self-extinguishing thermoplastic type with 105 degrees C (minimum) temperature rating.

B. Bushings with grounding lugs shall be malleable iron body with 105 degrees C (minimum) insulating ring. Insulating material shall be locked in place and non-removable.

2.10. EXPANSION / DEFLECTION FITTINGS

A. 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 sleeves, 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.

B. Expansion/deflection fitting shall accommodate the following movements without collapsing or fracturing the conduit and damaging the wires it contains:

1. Axial expansion or contraction up to 3/4-inch.

2. Angular misalignment of the axes of the conduits up to 30 degrees in all directions.

3. Parallel misalignment of the axes of the conduits up to 3/4-inch in all directions.

C. Expansion/Deflection fitting shall be OZ/Gedney Type "DX" or approved equal by Crouse Hinds (Type XD).

2.11. ENCLOSURES AND CABINETS

A. Hinged Cover Enclosures: NEMA 250, Type 1 in dry locations, and Type 4 in wet or damp locations, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

B. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

PART 3. EXECUTION

3.1. EXAMINATION

A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2. RACEWAY AND BOX REQUIREMENTS

A. Conduit Application Schedule:

APPLICATION	CONDUIT TYPE	REMARKS
In or under concrete slab	RNC (Schedule 40	Use RGS elbows to stub up through slab, unless

APPLICATION	CONDUIT TYPE	REMARKS
	PVC)	otherwise noted on the drawings.
Exposed exterior locations.	RGS	Use threaded or rain-tight fittings and stainless steel hardware.
Damp/Wet interior locations.	RGS	Use threaded or rain-tight fittings and stainless steel hardware.
Exposed dry interior locations	EMT, RGS	Schedule 40 PVC is acceptable for concealing grounding electrode conductors, except for plenum spaces. Provide RGS conduit where subject to physical damage.
Exterior underground.	RNC (Sched. 40 PVC)	RGS Elbows/Sweeps unless otherwise noted on the Drawings.
Equipment connections in dry interior locations.	FMC (e.g. Greenfield)	Short lengths only (maximum 6 feet).
Equipment connections in wet interior locations.	LFMC (e.g. Sealtite)	Short lengths only (maximum 6 feet). Use threaded or rain-tight fittings and stainless steel hardware.
Equipment connections in exterior locations.	LFMC (e.g Sealtite)	Short lengths only (maximum 6 feet). Use threaded or rain-tight fittings and stainless steel hardware.
Concealed in dry wall construction.	EMT, MC Cabling	Refer to Section 260519 “Conductors and Cables” for MC Cable Requirements.
Concealed above suspended ceilings.	EMT, MC Cabling	Refer to Section 260519 “Conductors and Cables” for MC Cable Requirements.
Concealed in masonry walls.	EMT	

B. General Requirements

1. Provide hot-dip Rigid Galvanized Steel Conduit (RGS) for exposed work in locations subject to physical damage.

2. Aluminum conduit is prohibited.

3. MC cable shall be permitted for emergency system wiring where concealed above accessible ceilings and/or within drywall partitions in accordance with the requirements of this Section”.

4. Conduits for exterior underground electric work shall be rigid steel, galvanized and sherardized, leaving the building and to points 5 feet beyond footings. Beyond 5 feet of building, underground conduits shall be non-metallic Schedule 40 PVC, Type II.

5. Conduits shall slope from entrance equipment toward outside of building.

C. Fittings:

1. All fittings to match conduit material and to be suitable for the purpose intended.

Join conduit with fittings designed and approved for the purpose and make joints tight.

2. Provide UL listed compound filled sealing fittings for NEC-required locations, for conduits passing from interior to exterior, and at the interface of widely different space temperatures such as refrigeration or cold storage rooms where conduits pass from warm locations to cool locations, such as the boundaries of air conditioned spaces and non-conditioned air spaces. For concealed conduits, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.

3. Provide expansion fittings with bonding jumpers where conduits cross expansion joints or where otherwise required to compensate for thermal expansion and contraction. Provide expansion fittings in each straight uninterrupted run of surface-mounted conduit, both horizontal and vertical, in excess of 200 feet. Distance between fittings shall not exceed 200 linear feet. The Contractor shall refer to the Architectural Drawings for expansion joint locations.

4. Fasten rigid steel conduit with threaded galvanized steel fittings, double locknuts, and insulated bushings. Insulated bushings shall be OZ/Gedney type "B", or equal.

5. Fasten EMT conduit with concrete-tight or rain-tight compression fittings made from zinc-plated steel. Fittings using set screw or indentations as a means of attachment or made from cast "white metal" are prohibited. All connectors shall have insulated throats.

6. Fasten liquid-tight conduit with fittings incorporating a threaded ferrule, nylon sealing ring, and steel or malleable iron compression nut and body. Furnish Crouse Hinds metallic liquid-tight fittings, or equal.

7. Fasten Flexible Metallic Conduit (FMC) with Thomas & Betts (T&B) "Tite-Bite" insulated connectors, or equal.

8. Watertight fittings shall use a copper base anti-corrosive conductive compound. Provide watertight fittings for conduits in damp or wet locations, underground locations.

D. Box Locations:

1. Electrical boxes shall accommodate wire pulling, splices, taps, equipment connections and Code compliance.

2. Coordinate access doors as required to provide access to boxes in hard ceilings and similar inaccessible areas.

E. Outlet Boxes:

1. Outlet boxes for dry interior locations and for concealed work shall be zinc-coated or cadmium-plated sheet steel boxes suitable for the service and type outlet.

2. Boxes and conduit fittings for damp or wet locations shall be NEMA 4 cast-

aluminum, cast steel or cast iron type with gasketed cover plates and threaded hubs for conduit entrance.

3. Extra large boxes shall be provided in accordance with the National Electrical Code where necessary to prevent crowding of wire in the box.

4. Plastic boxes and cast "white metal" boxes classified as NEMA 4 will not be acceptable.

5. Outlet boxes in unplastered brick or block walls shall be provided with deep square-cut device covers. They shall be set so that the brick or block can be cut and fitted closely to the cover opening and so that the standard wall plate will cover the joint between the brick or block and the box.

6. All outlet boxes used for supporting fixtures shall be furnished with malleable iron fixture studs of "no-bolt" type secured by locknut.

7. Provide support for boxes occurring in suspended ceilings. Outlets in ceilings directly on bottom of joists shall be supported independent of ceiling construction. Outlets in suspended ceilings shall not be supported from ceiling construction.

8. All boxes, whether outlet, junction, pull, or equipment, shall be furnished with appropriate covers.

9. No sectionalized boxes shall be used.

10. Back-to-back outlet boxes are not permitted. Separate boxes a minimum of 6" in standard walls and a minimum of 2 feet in acoustical walls.

11. Provide factory-made knockout closures for unused openings in outlet boxes.

12. Provide blank coverplates for all unused boxes.

13. For multiple device installations, provide multi-gang boxes. Sectional boxes are not permitted. Provide barrier separation of different voltage conductors in the same box.

14. Thoroughly coordinate mounting heights of boxes with casework and backsplash heights.

15. Provide recessed outlet boxes in finished areas, supported from interior partition studs. Supports are to be stamped steel stud bridges for hollow stud walls and adjustable steel channel fasteners for flush ceiling outlet boxes.

16. Provide back supports for boxes in metal stud walls.

F. Junction and Pull Boxes:

1. Junction and pull boxes shall be furnished and installed as shown or where required to facilitate pulling of wires or cables. Such boxes shall be installed in accessible locations. All boxes for concealed work shall be constructed of 12 gauge USS galvanized sheet steel minimum, unless otherwise specified or indicated and

provided with mounting brackets and flat screw covers secured in position by round head brass or stainless steel 300 grade machine screws. Boxes for exterior work shall be cast aluminum or galvanized cast iron type with threaded hubs unless otherwise directed. Gasketed cover plates shall be furnished for outdoor installation.

2. Provide barrier (separators) where different system voltage share the same box.

3. Wherever possible, locate pull and junction boxes above accessible ceilings in finished areas.

4. Pull or junction boxes shall be supported independently of conduit.

5. In flush grade outdoor applications, unit shall be adequately supported against settling or tipping. Where heavy traffic or poor soil compaction exists, cast box in a concrete base which provides 6" of cover around and under the box.

3.3. INSTALLATION OF RACEWAYS

A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.

B. Furnish and install a separate and independent raceway system as shown on the Drawings for each of the various wiring systems including, but not limited to, the following:

1. Communications System

2. Control Wiring

3. Fire Alarm System

4. Lighting

5. Power 120/208 volt

6. Power 277/480 volt

7. Security System

8. Telephone Wiring

C. All raceway systems shall be completely wired as specified herein, shown on drawings and/or required for satisfactory operation of the various systems.

D. Raceways, generally, shall be concealed conduit as specified herein. Where wiring troughs are required or used to facilitate the wiring installation, they shall be equal to Square D Company's Square-Duct and fittings, with hinged cover arranged for total removal, all finished in baked enamel and all components U/L listed. The gutters shall be of ample size to accommodate conductors therein and as required by the NEC.

E. Underground conduits for services outside of building and entrance into building shall be as specified herein.

F. Support all conduit not embedded in concrete or masonry such that strain is not transmitted to outlet boxes and pull/junction boxes, etc. Supports to be sufficiently rigid to prevent distortion of conduits during wire pulling.

G. Minimum Raceway Size:

1. 3/4 inch trade size for interior work

2. 1-inch trade size for exterior underground work**.**

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

I. Electrical Metallic Tubing (EMT) shall be used for the following unless otherwise indicated:

1. Branch circuits and feeders for lighting, receptacles, and power concealed in:

a. Dry wall construction.
b. Hard ceilings, e.g. gypsum, etc.
c. Masonry walls.

2. Exposed in equipment room areas as needed to serve fixed equipment.

3. Circuits for communication and signaling concealed in:

a. Dry wall construction.
b. Hard ceilings, e.g. gypsum, etc…

J. Rigid Galvanized Steel Conduit (RGS) shall be used for the following, unless otherwise indicated:

1. Branch circuits and feeders for lighting, receptacle and power, installed exposed in areas subject to physical damage.

2. Circuits for communication and signaling exposed in areas subject to physical damage.

K. Communications,, Automatic Temperature Control (ATC), Fire Alarm, and Security system wiring shall be installed in raceways within partitions, terminated 8” above accessible ceiling with 90 degree bend with insulating bushing on the end. Free-run cabling above accessible ceilings shall be supported by J-hooks and/or bridle rings at required spacing intervals. Cabling above inaccessible ceilings and in exposed locations shall be installed completely in raceway.

L. Wiring above ceiling shall be plenum rated cable, where required by Code.

M. Wiring installed concealed above hard ceilings and exposed in areas with no ceilings shall be installed in conduit.

N. Conduit shall be run concealed wherever possible, within walls, ceilings, or floors, unless otherwise indicated or specified. Where exposed conduits runs are shown or required, they

shall be run parallel to building construction and shall be suitably supported at required intervals.

O. Conduit may be run exposed in Mechanical Equipment rooms, Electrical rooms, and where necessary in Storage rooms and unfinished areas. Where conduit is run exposed, it shall be run as close as possible to walls and ceilings and shall not interfere with equipment, ductwork and piping.

P. Keep raceways at least 12 inches (300 mm) away from parallel runs of flues, steam or hot water pipes and other hot surfaces above 77 degrees F. Install horizontal raceway runs above water and steam piping.

Q. Install raceways level and square and at proper elevations. Provide adequate headroom.

R. Complete raceway installation before starting conductor installation.

S. Support raceways as specified in Division 26 Section "Hangers and Supports". Arrange supports to prevent misalignment during wiring installation.

T. Use capped bushings or "push-penny" plugs to prevent foreign matter from entering the conduit system during construction. Clean and plug or cap all conduits left empty for future use.

U. Protect stub ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab. Conduit stub-ups and stub-downs shall be arranged in a neat and orderly manner and shall emerge at right angles to floors or ceilings.

V. Make bends and offsets so the inside diameter is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

W. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.

X. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.

Y. Conduits may be installed in concrete floor slabs with the following limitations:

1. Maximum size –1-1/4".

2. Minimum concrete cover – 1", above and below.

3. Minimum spacing between conduits - 6" on center.

4. Conduit outside diameter - 1/3 of slab thickness, maximum.

5. Installed between bottom and top reinforcing, and centerline of conduit at the mid-depth of the slab.

6. Secured to prevent possible change in position, sagging, or shifting as concrete is

poured.

7. Water or damp-proofing integrity of slab is not disturbed.

8. Conduits larger than 1-1/4" may be installed in grade level concrete floor slabs only with the specific permission of the Engineer, or as specifically indicated on the drawings, all in accordance with the above limitation.

9. Conduits in close proximity to each other at panelboards, etc., shall be located and wrapped with wire mesh to prevent cracking of slab.

10. Transition non-metallic tubing to rigid steel conduit before rising above the floor.

11. Space raceways laterally to prevent voids in the concrete.

12. Run conduit parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place conduit close to slab support.

Z. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

AA. Run parallel or banked raceways together, on common supports where practical.

BB. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

CC. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.

2. Use insulating bushings to protect conductors.

DD. Tighten set screws of threadless fittings with suitable tools.

EE. Install pull wires in empty raceways. Use 14 AWG zinc coated steel 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 the pull wire.

FF. Stub up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver operated, threaded flush plugs flush with floor for future equipment connections.

GG. Lubricants for pulling wires shall be approved for use with the types of wire and conduit installed.

HH. Use conduit hubs to fasten conduit to boxes in damp and wet locations.

II. All metal raceways for circuits over 250-volts to ground shall be bonded per NEC Article

250.97.

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

KK. Avoid moisture traps; provide junction box with drain fittings at low points in conduit system.

LL. Die-cast fittings of pot metal will not be accepted.

MM. Conduits shall be free of any burrs, foreign objects, and water prior to conduit installation.

NN. Conduit placed against concrete or masonry above ground shall be fastened to the concrete or masonry with pipe straps or one screw clamp attached to the concrete by means of expansion screw anchors and screws. "Caddy Clip" type hangers or straps will be permitted only in non-exposed areas and restricted to 3/4" conduit.

OO. Where conduits turn up out of concrete slabs and are not concealed by wall construction, bends shall be carefully made so that no portion of the radius is above the floor.

PP. Rigid conduit or Electrical Metallic Tubing (EMT) shall not be strapped or fastened to equipment subject to vibration or mounted on shock-absorbing bases.

QQ. Conduit shall be installed in such manner as to ensure against the collection of trapped condensation, and runs of conduit shall be without traps wherever possible. Drill 1/8" diameter weep holes where necessary.

RR. Conduits run to and from cabinets shall be run neatly, in accurate manner and shall emerge from the floors and ceilings at right angles thereto.

SS. Provide wall flanges and gasketing on conduits entering fan housings to minimize air leakage at points of penetration of housing.

TT. Conduit risers shall be rigidly supported on the building structure, using appropriate supports only.

UU. Exposed conduit installed on or adjacent to ventilating ducts shall be installed after the ducts are in place, and shall be run from ceiling or wall junction boxes in such manner as to retain accessibility to junction box covers and to permit future removal or replacement of ducts.

VV. Conduits and other electrical items shall not be fastened to, or supported from ventilating ducts but shall be separately supported. The method of supporting and details of the supporting members shall be reviewed by the Owner's Representative. In no case shall screws penetrate the sheet metal of the ducts.

WW. Exposed conduit run on surface shall be supported according to Code and within three feet of each outlet, junction box, or cabinet, by galvanized malleable conduit clamps and clamp backs. Suspended conduits shall be supported every five feet by conduit hangers and round rods, or where two or more conduits are run parallel, by trapeze hangers suitably braced to

prevent swaying.

XX. Screws and other hardware for all work in damp/wet locations shall be stainless steel, unless otherwise noted.

YY. Zinc coated galvanized steel screws may be used for interior dry locations only.

ZZ. No running threads shall be cut or used.

AAA. Conduits which are installed at this time and left empty for future use and which are five feet or more in length, including all telephone and communication conduits shall have a non-ferrous, 600 lb. tensile strength drag line left in place for future use. All empty conduits including conduit stubs shall be tagged at all exposed ends with tags identifying the location of the end of the conduit.

3.4. INSTALLATION OF BOXES

A. Provide grounding connections for raceway, boxes, and components as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors.

B. Provide junction boxes, pull boxes, cable support boxes, and wireways as required for proper installation of the electrical work. Covers shall be accessible. Small junction boxes shall be similar to outlet boxes. Provide barriers (separators) where different system voltage wires share the same box.

C. Pull boxes, cable support boxes, and large junction boxes for indoor use shall be made of Code gauge steel or no less than 12 gauge. Covers shall be held in place with zinc-coated galvanized steel screws. Paint interior and exterior surfaces with rust-inhibitive paint. (Pull boxes and covers shall be hot-dipped galvanized.)

D. Boxes located outdoors and in damp or wet locations shall be cast metal or alloy, fitted with screw-fastened covers and gaskets, and with threaded conduit connections. Fasteners shall be stainless steel.

E. Pull boxes shall be installed at all necessary points to facilitate pulling of wires and to prevent injury to the insulation or other damage that might result from pulling resistance or for other reasons necessary for proper installation. Pull box locations shall be approved by the Owner's representative prior to installation.

F. Where boxes are used in connection with exposed conduit, plain covers attached to the box with a suitable number of countersunk flat head machine screws shall be used.

G. Pull boxes with barriers shall have a single cover plate and the barriers shall be of the same gauge as the pull box.

H. Exposed pull boxes will not be permitted in finished spaces.

I. Location of pull boxes shall be coordinated with piping, ductwork, and other equipment so as to permit sufficient clearance for maintenance and access.

J. Pull boxes recessed in walls or partitions shall be provided with flanged type covers.

K. Outlet boxes and covers shall be of proper Code size for the number of wires and/or conduits passing through or terminating therein, but in no case shall any box be less than 4" square.

L. Outlet boxes for lighting fixtures shall be equipped with fixture supporting devices.

M. Outlet boxes for switches shall be of the gang type.

N. Each circuit in each pullbox shall be marked with a tag guide denoting panels to which they connect.

O. Boxes shall be separated to prevent sound transmission. Back-to-back boxes shall not be used.

P. Outlet boxes shall be provided with suitable plaster rings and covers or plates.

Q. Unused knockout holes shall remain closed and those opened by error shall be closed with approved factory-made knock-out seals.

R. Outlet boxes installed in plenum ceilings shall be in accordance with applicable codes.

S. Outlet boxes shall be installed true and plumb so that the covers or plates will be level and at uniform elevations for the types of outlets contained.

T. Outlet boxes for toggle switches and pilot lights at doorways shall be located at the strike side of the door as finally hung.

U. Outlet box locations as indicated shall be considered to be approximate only. Determine exact locations from architectural details or from field instructions and coordinate outlet box locations with the work of other trades.

V. Install junction and pull boxes to be accessible.

W. Locations of junction and pull boxes requiring access panels shall be reviewed by the Owner's Representative.

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

3.5. INSTALLATION OF TERMINATIONS

A. Where raceways are terminated with lock nuts and bushings, align the raceway to enter squarely, and install the lock nuts with dished part against the box. Where terminations cannot be made secure with one lock nut, use two lock nuts, one inside and one outside of the box.

B. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

C. Open ends shall be capped with approved manufactured conduit seals as soon as installed and kept capped until ready to pull in conductors.

D. Where conductors enter a raceway, cabinet, pull box, and junction box, the conductors shall be protected by an insulated bushing providing a smoothly rounded surface.

E. Double lock nuts shall be used at termination of rigid conduit in knock-out openings.

F. Ends of conduits shall be equipped with insulating bushings for 1" and smaller, and insulated metallic bushings for 1-1/4" and larger. Ends of conduit shall be temporarily capped prior to installation and during construction to exclude foreign material.

3.6. FLEXIBLE CONNECTIONS

A. Provide Flexible Metal Conduit (FMC), e.g. Greenfield, in short lengths (maximum 6 feet) for the final connection of lighting fixtures, dry type transformers and vibrating equipment in dry interior locations. The flexible connections to recessed fixtures and equipment shall be sufficient slack to permit removal of the same.

B. Provide Liquidtight Flexible Metal Conduit (LFMC), e.g. Sealtite, in short lengths (maximum 6 feet) for the final connection of exterior equipment, motors and equipment in damp or wet locations as defined in Division 26 Section “Common Work Results for Electrical”.

C. Grounding conductors with green colored insulation shall be extended through all flexible connections including fixture "whips", and fastened to terminals within the first junction boxes on either side of the flexible length.

D. Flexible connections shall be sized per the Contract Drawings, or as required in accordance with Code; the more stringent requirement shall apply.

3.7. PAINTING AND FINISHES

A. All exterior equipment and conduits shall be painted to match adjacent surface in color as selected by Architect, unless otherwise indicated by the.

B. All exposed conduit, boxes, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

C. Conduit and boxes for fire alarm cabling and devices shall be red, except for finished locations, where they shall be painted to match adjacent surfaces.

3.8. PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to Manufacturer and Installer that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.

B. Repair damage to galvanized finishes with zinc rich paint recommended by manufacturer.

C. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

D. Steel conduit: Conduit that shows corrosion within the guarantee period shall be replaced.

3.9. CLEANING

A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

B. After conduits and accessories have been installed, and concreting operations completed, conduit runs shall be satisfactorily cleared of obstructions and foreign matter. Defects which might damage cable upon installation shall be corrected. Where new conduits installed are connected to existing conduits the entire run to the nearest box or other termination point shall be cleaned.

END OF SECTION

DIVISION 26 SECTION 260534
SURFACE METAL RACEWAY
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SECTION 26 05 34

SURFACE METAL RACEWAY

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 specification covers a surface metal raceway systems used for branch circuit wiring or data network, voice, video and other low-voltage wiring. The metal raceway systems shall consist of raceway, appropriate fittings and device boxes to complete installation per the Electrical Drawings.

B. In finished spaces, where conduit cannot be concealed and/or routed through existing walls, surface metal raceway shall be used. This applies to devices and equipment under Division 23 (e.g. thermostats, humidistats, control wiring, etc…), Division 26 (e.g. receptacles, switches, branch circuit wiring, etc…), Division 27 (data/voice outlets, communications cabling, etc…), and Division 28 (e.g. security devices, fire alarm devices, cabling, etc…)

C. The contractor shall thoroughly review the complete set of architectural drawings to determine existing wall types and locations.

1.3. CLASSIFICATION AND USE

A. Surface metal raceway is to be utilized in dry interior locations only as covered in Article 386 of the National Electrical Code, as adopted by the National Fire Protection Association and as approved by the American National Standards Institute. Surface metal raceway systems shall be listed by Underwriters Laboratories under File Nos. E4376 Guide RJBT and E41751 Guide RJPR.

1.4. SUBMITTALS

A. Submittals shall include catalog cuts of mounting devices, material sections, accessories, internal area descriptions, and wiring capacity charts. Submit sample of finish colors for final selection and approval.

B. Shop Drawings: Submit drawings for approval showing the complete layout of all products that make up the complete system for each floor prior to installation with raceway lengths, device type (power, voice video, data), locations and circuits identified.

C. As-Built Drawings: If variations from approved shop drawings occur during the installation of the systems, final As-Built Drawings shall be submitted for each floor that has been altered.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. The surface metal raceway system specified herein for branch circuit wiring or data network, voice, video and other low-voltage wiring shall be manufactured by The Wiremold Company, Hubbell, or Steel City. Systems of other manufacturers may be considered equal if, in the opinion, and the written approval of the Engineer, they meet all the performance standards specified herein.

2.2. MATERIALS

A. The raceway and all system components must be UL Listed. They shall be manufactured of steel; zinc plated, galvanized and/or finished in ivory ScuffCoat™ (a polyester topcoat over ivory base) and shall be suitable for field repainting to match surroundings.

2.3. SINGLE-CHANNEL SURFACE METAL RACEWAY - POWER

A. Description: The raceway shall be a one-piece design with a base and cover factory assembled. Nominal raceway dimensions shall be 3/4" wide by 21/32" deep, with an approximate cross-sectional area of 0.30 square inches. The raceway base and cover shall have an approximate thickness of 0.040". The raceway shall be available in five and ten foot lengths.

B. Fittings: A full complement of fittings must be available including but not limited to mounting clips and straps, couplings, flat, internal and external elbows, cover clips, tees, entrance fittings, conduit connectors and bushings. The covers shall be painted with an enamel finish, ivory in color to match the raceway. They shall overlap the raceway to hide uneven cuts. All fittings shall be supplied with a base where applicable. A transition fitting shall be available to adapt to other raceways.

C. Device Boxes:

1. Device boxes shall be available for mounting standard devices and faceplates. A device box shall be available in single- and multiple-gang configurations, up to six-gang. Single-gang boxes shall allow for snap-on and fastener application. Minimum depth shall be 2-1/4".

2. Provide extra deep boxes (nominal 4” depth) where required to accommodate large devices.

3. Extension boxes shall be available to adapt to existing standard flush switch and receptacle boxes.

4. Round fixture and extension boxes shall be available to mount fixtures and other devices with mounting centers of 1-15/32", 1-5/8", 1-23/32", 1-27/32", 2-3/4", 3-1/2" and 4-1/16" diameters. Round fixture and extension boxes shall be available in depths ranging from 0.47" to 1.00" and in diameters of 3.00", 4.75", 5.50" and 6.38".

5. All device and fixture box covers shall be painted with an enamel finish, ivory in color to match the raceway cover.

D. Basis of Design: Wiremold V700 Series raceway with 5700 Series device boxes.

2.4. SINGLE-CHANNEL SURFACE METAL RACEWAY – COMMUNICATIONS/CONTROL

A. Description: The raceway shall be a two-piece design with a base and cover factory assembled. Nominal raceway dimensions shall be 1-9/32" wide by 3/4" deep with an approximate cross sectional area of 0.80 square inches. The raceway base and cover shall have an approximate thickness of 0.040" and 0.025", respectively. The raceway shall be available in 5' lengths.

B. Fittings: A full complement of fittings must be available including but not limited to mounting clips and straps, couplings, flat, internal and external elbows, cover clips, tees, entrance fittings, conduit connectors and bushings. The covers shall be painted with an enamel finish, ivory in color to match the raceway. They shall overlap the raceway to hide uneven cuts. All fittings shall be supplied with a base where applicable. A transition fitting shall be available to adapt to other raceways.

C. Device Boxes:

1. Device boxes shall be available for mounting standard devices and faceplates. A device box shall be available in single-gang and two-gang configurations. Minimum depth shall be 1-3/4".

2. Provide extra deep boxes (nominal 4” depth) where required to accommodate larger devices, e.g. fire alarm notification devices.

3. Device boxes shall function as an extension box by removal of a rectangular knockout in the base.

4. All device and fixture box covers shall be painted with an enamel finish, ivory in color to match the raceway cover.

D. Communication Devices and Accessories:

1. The raceway manufacturer will provide a complete line of connectivity outlets and modular inserts for UTP/STP, Fiber Optic, Coaxial and other cabling types with face plates and bezels to facilitate mounting.

2. A complete line of preprinted station and port identification labels, snap-in icon buttons as well as write-on station identification labels shall be available.

E. Basis of Design: Wiremold 2000 Series raceway with 2000 Series device boxes.

PART 3. EXECUTION

3.1. INSTALLATION

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

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

C. Electrical Security: All metal raceway shall be electrically continuous and bonded in accordance with the National Electrical Code for proper grounding.

D. Raceway Support: Raceway shall be securely supported at intervals not exceeding 10 feet or in accordance with manufacturer's installation sheets.

E. Completeness: All raceway systems shall be installed complete, including insulating bushings and inserts, appropriate fittings, and mounting hardware. All unused raceway openings shall be closed. All fittings shall be furnished by the raceway manufacturer.

F. Provide grounding per the National Electrical Code and Local Codes. Maintain grounding continuity between raceway components to provide a continuous grounding path.

G. All surface metal raceways shall be installed parallel with and perpendicular to the structure. All exposed edges where field cut, shall be coated by the Contractor to prevent corrosion, and field-painted to match surface raceway finish.

H. Field cut straight cover sections between specific device covers.

I. Use flat-head screws to fasten channel to surfaces. Mount plumb and level. Channels shall be secured at least every four feet (1220mm) with two-hole straps.

J. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

K. Fastener Option: Use clips and straps suitable for the purpose.

L. Raceway surfaces damaged during installation shall be touched up with raceway manufacturer's matching paint.

M. Provide UL-approved expansion fittings, complete with grounding jumpers, where raceways cross building expansion joints.

N. Allow a minimum of 6-inches (152 mm) clearance from heat sources.

O. Surface raceways shall be visually seamless, without gaps between sections. Gaps exceeding the width of 1/16-inch shall be corrected to reduce width of gap.

P. Cut ceiling tiles tight to surface raceway, within a ¼-inch tolerance. Ceiling tile not cut tight to raceway shall be replaced at Contractor's expense.

Q. Provide manufacturer's touch-up paint. Paint all screws and scratches to match surface raceway.

3.2. REMODELING WORK

A. Surface metal raceway shall only be utilized where devices and/or wiring cannot be concealed in existing walls, unless otherwise indicated on the Contract Documents.

1. New devices installed in existing metal stud/GWB walls shall be cut in with conduit/wiring concealed within the wall.

2. New devices installed on existing CMU walls, where devices cannot be concealed, shall be installed in surface-mounted device boxes as specified in this section served by surface metal raceway as specified in this Section.

B. Exposed wiring on existing walls in finished areas, (e.g. classrooms, offices, corridors, toilets, etc.), shall be installed in surface metal raceways. The exposed raceways shall be run in corners, adjacent to door trims, and in other ways to be as inconspicuous as possible, even when requiring additional lengths.

C. All exposed raceways shall be painted to match adjacent surface(s) unless otherwise directed by the Architect.

D. All exposed raceways shall be installed in a manner approved by the Architect/Engineer.

E. The exposed runs shall not be across an open wall surface.

F. Horizontal runs of raceways shall be kept to an absolute minimum. Exposed raceway shall be run vertically into ceiling spaces above and below.

3.3. PAINTING AND FINISHES

A. All exposed surface raceway, boxes, etc. in finished spaces shall be painted to match adjacent surfaces. Colors shall be as selected by the Architect and shall conform to ANSI Standards.

END OF SECTION

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MISCELLANEOUS RACEWAY SYSTEMS
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MISCELLANEOUS RACEWAY SYSTEMS

PART 1. GENERAL

1.1. RELATED DOCUMENTS

A. Drawings and General Provisions of the contract, including general and Supplementary Conditions and Division 01 Specifications apply to this Section.

1.2. SUMMARY

A. This section includes requirements for miscellaneous raceway systems for the following:

1. Communications (data/voice) systems.
2. Audio/Video systems.
3. Security system.
4. Access Control System.
5. Video Surveillance System.

1.3. SCOPE OF WORK

A. Provide conduit, boxes, and surface raceways to form empty raceway systems.

B. Equipment and wiring will be installed under separate contract by Owner's Special and under System Contractors Division 27 and Division 28 unless otherwise indicated on the Contract Drawings or in another Section of these Specifications.

PART 2. PRODUCTS

2.1. CONDUIT

A. Minimum size 1" unless noted otherwise. Refer to Division 26 Section “Raceways and Boxes” for product requirements.

2.2. OUTLET BOXES

A. General Requirements

1. Provide single or multiple gang boxes as shown on the Contract Drawings.
2. Outlet boxes shall be listed to UL Standard 514A, Metallic Outlet Boxes.
3. Refer to Division 26 Section “Raceways and Boxes” for general product requirements.

B. Two-Gang Outlet Boxes

1. Description: Large capacity, two-gang, 4” deep outlet boxes with plaster/tile rings

as required to suit device quantities and types. Boxes shall have welded corners and device ears inside the box to prevent mortar from getting in the device holes. Boxes shall accept standard device and flat covers. Boxes shall have a ground screw in each gang. Provide supports to secure outlet boxes to concrete block to prevent movement during construction.

2. Dimensions: 4-1/4”H x 4”W x 4”D.

3. Capacity: 54 cubic inches.

4. Knockouts:

   a. Top: (2) 1/2", (2) 1/2"-3/4” tangential knockouts
   b. Bottom: (1) 1” - 1-1/4” - 1-1/2” - 2” concentric knockouts
   c. Back: (2) 1/2"-3/4” tangential knockouts

5. Provide Hubbell Catalog No. HBL985, or approved equal by listed manufacturer.

C. Three-Gang Outlet Boxes

1. Description: Large capacity, three-gang, 4” deep outlet boxes with plaster/tile rings as required to suit device quantities and types. Boxes shall have welded corners and device ears inside the box to prevent mortar from getting in the device holes. Boxes shall accept standard device and flat covers. Boxes shall have a ground screw in each gang. Provide supports to secure outlet boxes to concrete block to prevent movement during construction.

2. Dimensions: 4-1/4”H x 5-7/8”W x 4”D.

3. Capacity: 79 cubic inches.

4. Knockouts:

   a. Top: (3) 1/2", (3) 1/2"-3/4” tangential knockouts
   b. Bottom: (1) 1/2", (1) 1/2"-3/4” tangential knockouts, (1) 1” - 1-1/4” - 1-1/2” - 2” concentric knockouts
   c. Back: (3) 1/2"-3/4” tangential knockouts

5. Provide Hubbell Catalog No. HBL986, or approved equal by listed manufacturer.

2.3. PULL AND JUNCTION BOXES

A. Refer to Division 26 Section, “Raceways and Boxes”.

2.4. COVER PLATES

A. Device plates will be provided under Division 27 and Division 28.

2.5. SURFACE RACEWAYS

A. Refer to Division 26 Section “Surface Metal Raceway”.

PART 3. EXECUTION

3.1. INSTALLATION

A. Provide all raceway components, as required, for complete system. Extend conduits and/or surface raceways to nearest accessible ceiling space for devices with connections within the space, and to the nearest accessible corridor ceiling space for connections/cabling back to the MDF or IDF room, unless otherwise noted on the drawings.

B. Each run of conduit shall contain not more than two 90 degree bends and no run shall exceed 100 ft. in length. Minimum radii for bends: 10 1/2" for 1" conduit, and a minimum of ten times the trade size diameter bends for larger sizes. Do NOT use conduit fittings in lieu of bends.

C. Provide insulating bushings on all conduit terminations.

D. Provide pullboxes in conduit runs exceeding 100 feet (30 m) in length, and in runs with more than two right angle bends. Do NOT use conduit fittings in lieu of bends.

E. Identify all cabinets, and pull and junction boxes as to system usage.

F. Provide nylon pull cord in each conduit run.

G. Provide identification tags on all conduit runs.

H. Provide cover plates on all outlet boxes.

I. Provide plywood backboards and receptacles in equipment room(s) as shown on the Drawings. Confirm location on job site prior to installation. Paint all backboards with prime coat of fire resistant paint and finish coat of enamel in color to match wall. In unfinished rooms, provide gray finish coat.

J. Coordinate all work with Owner and Owner's Special System Contractor Division 27 and Division 28 Contractors.

END OF SECTION

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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 Specifications apply to this Section.

B. Sections of other Divisions in this Specification which relate to excavation and concrete construction.

1.2. SUMMARY

A. This Section includes complete concrete ductbank construction and direct burial materials and methods for outside power and communications systems transmission and distribution.

B. This Section specifies underground duct placement, materials, and installation procedures.

1.3. CONTRACTOR RESPONSIBILITIES

A. All work described in this Section shall be performed and paid for under Division 26.

B. Existing Subsurface Utilities: Existing subsurface facilities are shown on the plans to help the Contractor avoid damage to essential utilities which must remain in service. Take reasonable steps to ascertain the exact location of all underground facilities prior to doing work that may damage such facilities. If the discovery of underground facilities not indicated on the plans or in a location different from what is indicated on the plans, protect such facilities, notify the Owner's representative immediately, and record actual conditions found onto the record drawings.

C. Construction Staking:

1. Provide the stakes and reference marks necessary for the construction of the improvements covered by this Contract.

2. Control stakes which constitute reference points for all Construction work shall be conspicuously marked with red flagging tape. Provide responsibility to inform employees and Subcontractors of the stakes' importance, and the necessity for their preservation. The cost of replacing such controls, should it become necessary for any reason whatsoever, shall be furnished at no additional cost to the Owner.

1.4. QUALITY ASSURANCE

A. Installer: Company specializing in cast-in-place concrete structures with a minimum of three years documented experience.

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.

B. Materials: All materials shall be new and the best of their respective kinds, free from all defects and as specified on the plans and the specifications or as accepted by the Project Engineer. Furnish materials or manufactured articles of the best grade in quality and workmanship obtainable on the market from firms of established good reputation, or if not ordinarily carried in stock, shall conform to the usual standards of first-class materials or articles of the kind required, with due consideration of the use to which they are to be put. In general, the work performed shall be in conformity and harmony with the intent to secure the best standard of Construction and equipment of the work as a whole or in part.

C. Manufacturer's Recommendations: Whether specifically mentioned or not in these Specifications, all materials, equipment, devices, etc., shall be installed in a manner meeting the approval of the manufacturer of the particular item.

D. Codes and Standards: Provide underground ductbanks conforming to the following:

1. National Electrical Manufacturers Association (NEMA) - Conform to the manufacturing standards of the following:

   a. RNI: PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   b. TC 2: Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
   c. TC 3: PVC Fittings for Use with Rigid PVC Conduit and Tubing.
   d. TC 6: PVC and BAS Plastic Utilities Duct for Underground Installation.
   e. TC 7: Smooth-Wall Coilable Polyethylene Electrical Plastic Duct.
   f. TC 8: Extra-Strength PVC Plastic Utilities duct for Underground Installation.
   g. TC 9: Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.

2. Underwriters Laboratories, Inc. (UL): Conform to the following:

   a. 6: Rigid Metal Conduit.
   b. 651: Schedule 40 and 80 Rigid PVC Conduit.
   c. 651A: Type EB and A Rigid PVC Conduit and HDPE Conduit.

3. American Concrete Institute (ACI):

   a. 318: Building Code Requirements for Reinforced Concrete.

4. American Society for Testing & Materials (ASTM)

   a. F512: Smooth-Wall PVC Conduit & Fittings for Underground Installation.

E. Certification: Manufacturer shall be a company specializing in ductbank structures with a minimum five years documented experience.

1.5. SUBMITTALS

A. Submit shop drawings and product data for all conduit, duct, ductbank materials,

accessories, and miscellaneous components. Submit product data for each type of manufactured material and product indicated.

B. Indicate material specifications, dimensions, capacities, and reinforcing details. Submit concrete product data, concrete mix design, and certified mill test reports for steel bars.

C. Submit coordination shop drawings of ductbank and underground cable installations including profiles and elevations of all utility crossings. Proposed deviations from details on the Drawings shall be clearly marked on all Submittals.

D. Record Documents: Show dimensional locations of underground ducts, and handholes,.

1.6. SITE CONDITIONS

A. General: Clearing work shall not begin until temporary fences, barricades, warning signs and other pedestrian control devices are installed.

B. 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. Provide responsibility for coordinating and obtaining approvals of the location for temporary barricades and/or detours of traffic from the Police and Fire Departments.

3. If peripheral fencing is used, it shall be provided with reflectors, flashers, signs, dangles, or barricades as the fence is being built.

4. Maintain continued access to parking areas, roads, abutting properties, and other facilities which the construction will cross.

5. If traffic is reduced to one way, provide a flag person. A minimum of one lane shall be maintained open to traffic at all times.

6. When entering or leaving road ways carrying public traffic, the equipment whether empty or loaded, shall in all cases yield to public traffic.

7. Supply and maintain cone placements at his sole additional expense.

8. All traffic signs which fall within the line of Construction or are obstructed by the equipment or operations shall be temporarily relocated to an unobstructed area. Temporarily relocated traffic signs shall be returned to their original location at the end of construction.

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. Conduit and Fittings:

   a. Carlon Electrical Products.
   b. George-Ingraham Corporation.
   c. Condux International.

2. Ductbank Accessories:

   a. Carlon.
   b. Osburn Associates.
   c. Underground Devices, Inc.
   d. OZ/Gedney

2.2. UNDERGROUND DUCTBANKS

A. General: Underground ductbanks to be arrangements of single bore, PVC plastic conduits concrete encased. The number and size of conduits to be as indicated. Turn up connections through slabs or floors shall be rigid metal.

B. Material:

1. Conduit and Fittings:

   a. Type II, heavy wall Schedule 40 PVC plastic, sunlight UV-resistant, in accordance with the requirements of NEMA publications TC-2 and TC-3 (fittings).
   b. Rigid galvanized heavy wall steel conduit (UL 6) with threaded couplings.
   c. Rigid Metal Conduit, PVC Coated, UL 6, galvanized steel, threaded type, coated with a polyvinyl chloride (PVC) sheath bonded to the galvanized exterior surface, nominal 40 mils thick, conforming to NEMA RN 1, Type A40.
   d. Conduit and fittings shall have a temperature rating at least equal to the operating temperature of the cable which it contains, minimum 90 degrees C. Conduit and fittings shall be free from all substances that injuriously affect any wire or cable insulation.
   e. The Manufacturer shall certify that the plastic is 100 percent virgin material and the finished product meets the specifications. All PVC conduit and fittings shall have solvent-weld connections and shall provide a water-tight joint.
   f. Cement: Portland Blast-Furnace Slag Cement, Type IS or equal meeting ASTM C593M Specifications and the requirements of ACI 318 and 301.
   g. Fine Aggregate: Concrete sand meeting requirements of ASTM C33.
   h. Course Aggregate: ASTM #57 crushed limestone, meeting requirements of ASTM C33.
   i. Air Entraining Admix: Complies with ASTM C260 Standard

Specifications for Air Entraining Admixtures for Concrete.

j. Water: Complies with ASTM C94 Standard Specifications for Ready-mixed Concrete.

2. Use pea gravel aggregate for void-free duct penetration.

3. Reinforcing: Deformed conforming to ASTM A615 - Grade 40, minimum 3/4". Provide coated rebar where exposed to earth, such as on ductbank stubouts. Bars shall be free of loose scale, rust, or other coatings that will reduce bond.

4. Spacers: Manufactured precast plastic assembly, base spacer, top spacers and intermediate spacers, to maintain 4-inches between conduits and completely enclosed and locked conduit assembly. Set on masonry leveling blocks.

5. Joint Sealant: Watertight as recommended by conduit manufacturer.

6. Cable Sealing Bushings: OZ type CSB, with PVC coated discs, or equal.

7. Thruwall and Floor Seals: OZ type FSK or WSK, or equal.

8. Expansion Joints: Expansion joints shall be Dylite, as manufactured by Copper, Scorogord, or Dow Chemical and shall conform to ASTM D-1752, Type II.

9. Construction Joints: Construction joints shall be formed using Jahn Screed Joint materials as manufactured by Superior Concrete Accessories, Inc.

C. Conduit

1. Size as indicated on the Drawings. If conduit sizes are not indicated on the Drawings, then the conduits shall be sized as follows:

a. Four inches nominal for 600 volts or lower and for Communication
b. Five inches nominal for voltages above 600 volts.

D. Elbows: rigid heavy wall galvanized steel with a minimum bend radius of 36 inches (915 mm).

E. Conduit Termination in Utility Holes and Buildings

1. End Bells: Manufactured end bells of appropriate sizes at each end of conduit. When entering a new building or a new manhole, the end bells for PVC shall be a pre-manufactured system (as manufactured by Formex, or equal) with conduit seals, provision for roughing into the concrete, and water stops.

2. Bushings: Pre-manufactured groundable steel bushings of appropriate sizes where bell ends are not used. Steel bushings shall be used on all metal conduit. When entering a new building, or a new manhole, the bell ends for PVC shall be a pre-manufactured system (System as manufactured by Formex or equal) with conduit seals, provisions for roughing into the concrete pour and water stops.

3. Seals: When entering, below grade, an existing building or manhole, the concrete shall be core-drilled for the appropriate size conduit and seal. The seal shall be a

mechanical interlocking assembly seal of modular synthetic rubber links properly sized to fit the pipe and tightened in place, in accordance with the manufacturer's instruction.

4. Fire Stopping/Sealant: All cable filled conduits shall be sealed with 3M Fire Barrier 2001 Silicone RTV Foam Conduit Sealant manufactured by 3M Fire Protection Products, or approved equal.

F. Plugs: Closure plugs or caps of the same material as the conduit at the ends of the unused sections at manholes, and at building entrance openings.

G. Pull wire: Provide a polypropylene, twisted yellow, rot and mildew-resistant 3/8" minimum pull rope (2400 lbs. tensile strength) in each empty duct.

H. Grounding: Rigid steel conduit with end bells shall be provided with an Appleton Catalog No. XJB Series or equal ground bushing with bonding strap. Connect bonding strap to ground wire in handholes.

I. Drainage Assembly: All ducts shall drain to an open end away from the building or electrical equipment. Ducts shall drain towards handholes wherever possible.

2.3. ACCESSORIES

A. Duct Supports: Rigid PVC spacers selected to provide minimum duct spacings and concrete cover depths indicated, while supporting ducts during concreting. Spacers shall be interlocked horizontally only. Provide nylon tie-downs to hold ducts to spacers. Concrete blocks are prohibited for duct spacers.

B. End Bells: Flared, smooth-surfaced fittings of same material as conduit; if of different material, including adapter for connection to conduit.

C. Underground Line Warning Tapes:

1. Refer to Division 26 Section, “Electrical Identification” for product requirements.

2. Bury underground line warning tape 12-inches below grade above every ductbank and buried conduit.

PART 3. EXECUTION

3.1. LOCATION AND LAYOUT

A. Indicated plans and profiles: Approximate, based on field information and available as-built plans.

B. Actual locations and profiles: Based on test pits to locate all shown utilities and structures. Test pits at beginning, center, end, and at all ductbank bends and utility crossings.

C. Plan and profile adjustments: All provided at no additional cost to Owner, subject to approval.

D. Examine site to receive underground ductbanks for compliance with installation tolerances

and other conditions affecting performance of the underground ductbanks. Do not proceed with installation until unsatisfactory conditions have been corrected.

E. Connection to existing duct banks: Contractor to verify location and inverts of existing duct banks, at points of connection.

3.2. INSTALLATION

A. In accordance with NEMA publication TC-2 and manufacturer's recommendations.

B. Top of envelope below grade: Minimum as indicated on the Drawings.

C. Seal and Thru Wall Fittings: At entrances to buildings for watertight construction.

D. Sweeps and bends: Minimum 25 foot radius (except at conduit risers) unless otherwise approved to accomplish changes in direction of runs either horizontally or vertically. Double offsets: Minimum 100 foot radius. Sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 36 inches.

E. Mandrel conduits: Mandrel 12 inch long, 1/4 inch less than conduit I.D. Draw a testing mandrel through each duct.

F. Clean conduits: After mandrel, with stiff brush, leave no particles or debris. Immediately install end plugs after cleaning.

G. Pull Line: Provide 100-pound-tested nylon pull line in all conduits, including spares. Provide 3 feet of slack at each end of conduit and tag.

H. Stagger vertical conduit joints: Minimum 6 inches. All joints shall have couplings installed.

I. Reinforcing steel: Provide reinforcing steel the entire length of the duct system. Provide four #4 bars, one in each corner minimum, overlap the joints 12-inches, and tie them into the respective utility, vaults, and buildings, etc. Rebar shall not be installed less than 2-inches from sides of any duct.

3.3. EXCAVATION, BACKFILLING, COMPACTING AND SITE PREPARATION

A. Provide all excavating and backfilling and site preparation necessary to install underground ductbanks, cables, etc., included in this section of the work. Excavation and backfill shall be performed in accordance with the requirements of Division 26 Section, “Common Work Results for Electrical”.

B. Install forms on sides of the ductbank if the trench is not of the proper firmness to prevent cave-in. Provide all required excavating, shoring, sheeting, bracing, and backfilling.

C. The bottom of the trench shall be undisturbed earth. If the trench bottom is too low for proper grade, fill to the proper level with sand and mechanically compact it. Cut trenches neatly and uniformly.

D. Each excavated section between utility holes and from utility holes to the building shall be

completely excavated and graded before any duct is laid in that section.

E. Provide underground line warning tape 12-inches below finished grade over all ductbanks. Refer to Division 26 Section "Electrical Identification" for product requirements.

F. Excavation and Backfill: Refer to Division 26 Section "Common Work Results for Electrical".

G. After excavation of the trench, stakes shall be driven in the bottom of the trench at four-foot intervals to establish the grade and route of the duct bank.

H. Pitch the trenches uniformly towards utility holes or both ways from high points between utility holes for the required duct line drainage. Avoid pitching ducts towards buildings wherever possible.

I. The walls of the trench may be used to form the side walls of the duct bank provided that the soil is self-supporting and that concrete envelope can be poured without soil inclusions. Forms are required where the soil is not self-supporting.

J. After the concrete-encased duct has sufficiently cured, the trench shall be backfilled to grade with earth.

K. Restore surface features at areas disturbed by excavation, and reestablish original grades except as otherwise indicated. Replace removed sod as soon as possible after backfilling is completed. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching..

L. Restore disturbed paving.

M. Remove pavements, sidewalks, curbs, and gutters where necessitated by construction of ducts.

N. Surplus earth from the trenches, after compacting, shall be removed and disposed of.

3.4. CUTTING AND PATCHING

A. Provide all cutting and patching necessary for the installation of the electrical work. Any damage done to the work already in place by reason of this work shall be repaired expense by a qualified mechanic experienced in such work. Patching shall be uniform in appearance and shall match with the surrounding surface.

B. Existing Obstructions: Where drawings indicate that underground conduits are to cross under existing roadways, walks or other similar paved areas, steel conduits shall be driven under such areas in lieu of installing the conduits in trenches as specified above. After installation of conduit by either method, all existing paved or grass areas which have been disturbed in any way shall be restored to their original conditions.

C. Spare Conduits: Where drawings indicate spare conduits under existing roadways, walks, and other similar paved areas, all ends of conduits shall be capped five feet beyond the pavement and adequately protected from mechanical damage. The ends of these conduits

shall be marked by the placement of concrete monuments. Minimum size shall be 6 inches in diameter by 18 inches long set flush in ground with "S/C" indented in top to signify spare conduit.

D. Work with extreme care near existing ducts, conduits, cables, and other utilities to avoid damaging them.

3.5. PLACEMENT OF CONDUIT

A. Install spacers as recommended by the conduit manufacturer and requirements stated above, but not to exceed a maximum of four feet on center for PVC conduit and eight feet on center for steel conduit. Bottom spacers shall rest on 8-inch x 16-inch x 2-inch minimum concrete pads to prevent them from sinking into the ground and reducing the bottom concrete cover. Stagger conduit joints in concrete encasement 6 inches minimum horizontally.

1. Spacer assembly shall consist of base spacers, intermediate spacers, and top spacers to provide a completely enclosed and locked conduit assembly.

2. Before placing concrete, anchor duct bank assemblies to prevent the assemblies from floating during concrete placement. Anchoring shall be done by driving reinforcing rods adjacent to every other duct spacer assembly and attaching the rod to the spacer assembly.

3. Set on masonry leveling blocks prior to pour.

B. Pitch conduit properly for drainage to handholes and to prevent low pockets or irregular dips between conduit ends. Minimum pitch to be 4 inches per 100 feet.

C. Provide accurate locations of conduit in utility hole.

D. Depending on encasement necessary for duct formation, place conduits on spacers. The minimum encasement thickness 1-1/2-inches on all sides.

E. Lay conduits using spacers to provide tier spacing.

F. Make tight conduit joints by complying with recommendations of conduit manufacturer, using coupling jointing compound or PVC primer and solvent cement. All joints in conduits and fittings shall be made up tight and shall be watertight. All threaded portions of steel conduits that are not to be encased in concrete and adjoining ends of conduits, couplings and fittings, shall be heavily coated with asphaltum after installation. All connections between conduits of different types shall be made in an approved manner, using adapters of other materials and methods recommended for the purpose by the conduit manufacturers.

G. Provide not more than one 90-degree bend or equivalent between pull points for primary conduit and two 90-degree bends or equivalent for signal conduit.

H. In ductbanks with both primary and signal conduit, primary conduit shall be straight and the signal conduit shall contain bends as necessary to accommodate the primary duct. Any offsets or bends shall be made in steel conduit. PVC conduit may only be used in straight

lengths.

I. Provide end bells on ducts at utility holes. When entering a new building or a new manhole, end bells shall be a pre-manufactured system (system as manufactured by Formex or equal) with conduit seals and provisions for roughing into the concrete.

J. Provide insulated, grounding bushings on duct ends in equipment enclosure.

K. Plug or cap empty conduits. Provide standard manufactured plugs.

L. Seal all ducts and conduits, at both ends with foam duct sealant to prevent the entrance of moisture and gases. Refer to Division 26 Section “Common Work Results for Electrical” for product requirements.

M. After ducts are in place and before the concrete is poured, the installation shall be inspected by the Engineer. Notify the Engineer at least two days before the time of inspection.

N. Clear conduit by rod and pull an approved test mandrel from structure to structure or from structure to the conduit termination.

O. Leave nylon or polyester pull line in each conduit, tagged to identify the conduit's point of origin, contents and final destination.

P. Conduit Couplings: Conduit couplings shall be staggered so that couplings on adjacent conduits will not lie in the same transverse plane. End bells shall be spaced approximately 9 inches center to center at face of manhole wall for 4-inch conduits and proportionately spaced for other sizes. The change from regular conduit spacing to end bell spacing shall start 10 feet from the face of the manhole wall and shall be made in such a way that the slope of any conduit will not be less than that of the main bank and no trap will be formed. New conduit entrances into existing manholes and building walls shall enter at the most desirable locations consistent with grading requirements and existing entrance and shall be waterproofed in a satisfactory manner.

Q. Bends: Conduit generally shall be straight between manholes or upturned elbows. Where bends are unavoidable in non-metallic conduits, they may be made by assembling couplings at a slight angle, provided the watertight seals are not broken and the resulting radius is not less than 100 feet. For radii less than 100 feet, 5-degree angle couplings or 5-degree factory-made bend sections shall be used.

R. Install top of duct bank minimum 30 inches below finished grade.

S. Multiple conduit: Install multiple conduit as follows:

1. Multiple conduit runs, direct burial or in duct bank, shall be supported on preformed, non-metallic separators. Spacing between exterior surfaces of conduits generally shall be not less than the following:

   a. Two (2) inches between conduits containing cables operating at not over 600 volts.
   b. Two (2) inches between conduits containing cables operating at over 600 volts.

c. Two (2) inches between telecommunications conduits.

d. Six (6) inches between a telecommunications conduit and any power conduit in the same envelope.

e. Spacing between separators shall be close enough to prevent sagging of conduits and breaking of couplings and watertight seals. Separators shall also be spaced to keep deformation of conduit at the separators to 0.10-inch or less. Separators shall be secured with cords where necessary and no tie wires, reinforcing rods or other metallic materials shall be placed around the conduits, either individually or in groups, in such a manner as to form a magnetic loop.

2. Multiple conduit runs shall be arranged substantially as shown on the drawings, but minor changes in location or cross sectional arrangement shall be made as necessary to avoid obstructions. Where conduit runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, the condition shall be referred for instructions before further work is done. All underground conduit work shall be coordinated with other outside service work. Existing outside services shall be maintained in operation unless directed otherwise.

3.6. CONDUIT AND DUCT INSTALLATION

A. Install nonmetallic conduit and duct as indicated according to Manufacturer's written instructions.

B. Slope: Pitch ducts a minimum of 4 inches per 100 feet (1:300) to drain toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two (2) manholes to drain in both directions. Trenches shall be evenly graded so that conduits will have a uniform rate of fall of not less than 3 inches per 100 feet and will be free from either horizontal or vertical waves. Unless otherwise specified, each conduit shall slope uniformly from one manhole to the next or from a high point between manholes. Low points between manholes or between upturned elbows, shall be avoided wherever possible. Where it is not possible to avoid a trap or low point in a conduit which has no concrete envelope, provide a 1/2-inch hole drilled in the bottom of the conduit at the low point and a crushed stone sump of suitable volume below the conduit. If possible, install the sump above the high water table elevation for the particular location. Otherwise, provide special means to prevent the accumulation of water within the conduit.

C. Curves and Bends: Use manufactured elbows with a minimum radius of 36 inches for stub-ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of 25 feet both horizontally and vertically at other locations.

D. Make joints in ducts and fittings watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

E. Installation of warning tapes: After placing a minimum of 12 –inches or a maximum of 18 inches of backfill over the ducts, place the appropriate warning tapes above and parallel to the centerline of the duct for the entire length of the duct trench.

F. Provide pull rope and measuring tape at the time a mandrel is pulled through each conduit. Record the wall-to-wall measurements and the size of mandrel used at this time. Provide

this documentation to the Project Engineer on the following working day. After acceptance of these documents, the Contractor shall remove the measuring tape, leaving only the pull rope in the conduits.

G. All work and materials covered by these Specifications shall be subject to inspection at times by the Owner's designated representative. Any work concealed before it has been inspected by the Owner's designated representative shall be re-opened or uncovered and any required modification made to that portion of the work. All trenches shall be opened from manhole to manhole or manhole to building prior to laying conduit in that trench. Exceptions (such as street crossings) will be approved prior to excavation on a case-by-case basis by the Owner at a regular project meeting. These sites shall be inspected by the Owner's representative during excavation, installation, backfill, restoration, and cleanup.

H. Separation distance from other buried utilities as follows:

1. All others: 18-inches.

3.7. REUSE OF EXISTING DUCTBANKS

A. Where new cables are to be installed in existing ductbanks and conduit, mandrel and brush clean each duct prior to installation of new cable. Mandrel and brush procedures shall be as specified for new conduit and ductbanks. If any duct is found to be collapsed, or deformed, it shall be brought to the attention of the Engineer immediately.

3.8. DIRECT BURIED CONDUIT

A. Provide where indicated direct-buried electrical circuits utilizing PVC Schedule 40 conduit, as indicated. Conduit shall be as specified in Division 26 Section, “Raceways and Boxes”. Burial depth shall be as follows:

1. Below paved roads: 36-inches below bottom of paving.

2. Under non-vehicle concrete: 30-inches below bottom of paving.

3. Other areas: 30-inches.

B. Minimum separation from other utilities shall be the same as for ductbanks, specified previously in this Section.

C. Where feasible, and where indicated, install direct-buried lines parallel, but separated from other utility lines. Group several direct-buried conduits in a common trench where running in the same direction, or to/from the same source. All direct-buried conduits shall have detectable warning tape buried midway between the conduit and finished grade. Tape shall be the same as used for ductbanks.

D. Where direct-buried conduits penetrate walls or floor slabs, seal all spaces around conduit and fittings.

E. Where an underground conduit, without a concrete envelope, enters the building through a non-waterproofed wall or floor, provide a sleeve made of Schedule 40 galvanized pipe. The space between the conduit and the sleeve shall be filled with a suitable plastic

expansible compound or an oakum and lead joint on each side of the wall or floor in such a manner as to prevent entrance of moisture. A watertight entrance sealing device hereinbefore specified will be acceptable in lieu of the sleeve.

3.9. RECORD DOCUMENTS

A. Provide record set data of the actual elevation of the top of each end of each raceway or ductbank at the midpoint, at no more than 100 foot intervals, where changes in elevation are less than 2 feet between data points, or 10 foot intervals when the elevation between intervals is different by 2 feet or more between data points.

B. Provide record drawings indicating actual locations of all installed ductbanks and handholes including elevations. The record drawing shall indicate location, elevation, and type of service for all utilities crossed by new ductbank.

C. Cable Records: The Contractor shall provide a complete listing of all cables installed in each conduit and ductbank, along with all cable splice locations.

3.10. FIELD QUALITY CONTROL

A. Field inspection and testing shall be performed under provisions of Division 26 Section "Common Work Results for Electrical" in the presence of the Engineer.

B. Backfilling shall not be done until the concrete has cured for at least three calendar days.

C. Exposed surfaces of concrete shall be kept wet (damp) throughout the curing period.

D. Upon completion of the duct bank installation, a standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material left in the line. The mandrel shall be not less than 12 inches long, and shall have a diameter 1/4-inch less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. The diameter of the brush shall be the same as, or slightly larger than, the diameter of the duct.

E. Seal the ducts and conduits at building entrances, and at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of moisture and gases.

END OF SECTION

DIVISION 26 SECTION260545
UTILITY HOLES
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SECTION 26 05 45

UTILITY HOLES

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. Provide all labor, materials, equipment, and services necessary to provide handholes as required.

B. The Contractor shall be responsible for the structural integrity of each utility hole as installed including its associated components such as: bearing capacity of the coil or fill supporting it, cover and rim, utility hole and openings through utility hole surfaces.

1.3. RELATED WORK

A. Related Sections include the following:

1. Division 26 Section "Common Work Results" for excavation and backfill requirements.

2. Division 26 Section "Conductors and Cables" for conductors installed in raceways and boxes and conductor terminations.

3. Division 26 Section "Underground Ductbanks" for direct-buried conduits terminating at utility holes.

1.4. QUALITY ASSURANCE

A. Manufacturer Qualifications: Firm experienced in manufacturing underground precast concrete or cast-in-place 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: National 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 conduits, handholes with final arrangement of other

utilities as determined in the field.

E. Coordinate elevations of conduit and ductbank entrances into handholes 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 and ensure duct runs drain to handholes, and as approved by the Engineer.

F. The following Codes, Regulations, Reference Standards and Specifications apply to work included in this Section:

1. Codes and regulations of the jurisdictional authorities.

2. Codes and Standards, Section 01060:

a. AASHTO Standards: M199 - Precast Reinforced Concrete Utility Hole.
b. ANSI: C80.1.
c. ASTM: A36, A48, A153, A386, A615, C33, F512.
d. Federal Specifications:
i. TT-P-0035.
ii. RR-F-621E Frames, Covers, Gratings, Steps, Sumps, and Catch Basin Utility Hole.
iii. SS-S-210A, Sealing Compound, Pre-formed Plastic for Expansion Joints and Pipe Joints.
e. National Electrical Code, NFPA-70.
f. American Concrete Institute (ACI):
i. 318 - Building Code Requirements for Reinforced Concrete.

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 handholes, and accessories.

1.6. PROJECT RECORD DOCUMENTS

A. Submit under provisions Division 26 Section, “Common Work Results for Electrical”.

B. Accurately record actual locations and depths of each handhole.

1.7. DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Division 26 Section, “Common Work Results for Electrical”.

B. Store precast concrete units at 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.

1.8. COORDINATION

A. Obtain all available information on underground utilities before starting excavation. If underground utilities interfere with shown location of handholes, bring this to the attention of the Engineer as soon as possible. The utility hole shall be revised or relocated only with the approval of the Engineer.

B. Coordinate exact location of each handhole centerline based on local grade, new and existing utilities, and other items which may affect placement.

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. Precast Polymer Handholes and Pullboxes:

   a. Hubbell Quazite
   b. Jensen Precast
   c. Oldcastle

2.2. PRECAST POLYMER HANDHOLES AND PULL BOXES

A. Description: Precast polymer concrete enclosures for use as hand holes, pull boxes, splice boxes or equipment enclosures for underground utility services.

B. Construction:

1. Polymer concrete shall be made from selectively-graded aggregates in combination with a polymer resin, and shall be reinforced with fiberglass for exceptional strength and rigidity.

2. Covers shall be heavy-duty type with gasket to reduce incoming fluids into the enclosure. Covers shall be secured to enclosures with stainless steel bolts.

C. Dimensions:

1. Enclosures shall be sized as indicated on the Contract Drawings, unless otherwise noted or required by the National Electrical Code based on size and layout of conduits terminated at the same.

2. Provide enclosures where required for long underground conduit runs, in addition to enclosures indicated on the Contract Drawings.

3. Enclosures shall be no less than 11-inches x 18-inches x 18-inches deep.

D. Covers:

1. Heavy-duty type with non-skid surface, same design load (Tier level) rating as

respective enclosures.

2. Tier level ratings shall be embossed on the surface of all covers.

3. Gasket to reduce incoming fluids into the enclosure, secured to enclosures with stainless steel bolts.

4. Factory embossed with lettering (minimum 1/2" high text) to identify system served by enclosure, as follows:

a.	Power, 600V or Less:	Electric
b.	Lighting:	Lighting
c.	Telecommunications:	Communications
d.	Telephone:	Telephone
e.	Cable Television:	C.A.T.V.
f.	Optical Fiber:	Fiber Optics

E. Installation: Enclosures shall sit flush with finished grade elevation. Provide a minimum of 6-inch layer of compacted gravel for drainage, with filter cloth between handhole and gravel layer.

F. Quality Assurance:

1. Enclosures and covers shall conform to all test provisions of the most current ANSI/SCTE 77 “Specification for Underground Enclosure Integrity” for Tier 15 (minimum) applications and shall be UL listed. Refer to Contract Drawings for Tier Ratings of individual handholes.

2. Independent third party verification or test reports stamped by a registered Professional Engineer certifying that all test provisions of this specification have been met shall be included with product submittal.

G. Basis of Design: Quazite PG style enclosures, as manufactured by Hubbell.

PART 3. EXECUTION

3.1. EXCAVATION

A. Provide responsibility for all demolition, excavation and backfilling required to install hand holes.

B. After completion of hand hole 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. INSTALLATION – HANDHOLES AND PULLBOXES

A. Install and seal precast sections in accordance with manufacturer's instructions.

B. Use gasketed precast neck and shaft sections to bring utility hole entrance to proper elevation.

C. Install utility holes plumb.

D. Set the top of each utility hole to finished grade elevation.

E. Provide where indicated and where required for long underground wire runs. Larger dimensions may be required per NEC for cables involved.

F. Handholes shall be set level and adjusted for the final grade.

G. All wiring within handholes, whether spliced or not, shall be identified with permanently indented or engraved tags as to circuit origination, circuit #, and load served.

3.3. GRADE ADJUSTMENTS TO SURFACE STRUCTURES

A. Frames and Covers:

1. Frames and covers of all handholes shall be adjusted to proposed finish grade. Grade rings shall be supplied and installed as required.

3.4. CLEANING

A. Pull brush through full length of ducts. Use round bristle brush with a diameter 1/2 inch (12 mm) greater than internal diameter of duct.

B. Clean internal surfaces of handholes. Remove foreign material.

C. Remove debris from handholes and ensure complete installation is left in neat and finished condition.

END OF SECTION

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ELECTRICAL IDENTIFICATION
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SECTION 26 05 53

ELECTRICAL IDENTIFICATION

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 electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

B. This section includes labeling of all terminations and related subsystems; including, but not limited to, nameplates, wire and cable markers, labeling and identification of cables, equipment and other products.

1.3. SUBMITTALS

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

1.4. QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

D. Comply with applicable EIA/TIA Standards.

E. Comply with OSHA Standards.

1.5. DEFINITIONS

A. Emergency systems include, but are not limited to, generator circuits and systems, fire alarm systems, exit sign circuits, emergency lighting circuits, etc.

PART 2. PRODUCTS

2.1. RACEWAY AND CABLE LABELS

A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

1. Color: Black letters on orange field.

2. Legend: Indicates voltage and service as well as circuit designation for all feeders.

B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend, overlaminated with a clear, weather- and chemical-resistant coating.

C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.

D. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 3/4 inch wide, in appropriate colors for system voltage and phase.

E. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

2.2. WIRING DEVICE FACEPLATE LABELS

A. Adhesive Labels:

1. Thermal transfer printable, clear polyester material with glossy finish, 1/2" high, width as required. Printed lettering shall be 1/4" high black text.

2. Labels shall be backed with permanent acrylic adhesive and shall exhibit good adhesion to many metal and other types of surfaces, including textured surfaces and low surface energy plastics.

3. Labels shall be resistant to humidity, temperature and UV light.

4. Labels shall meet requirements of UL 969 Labeling and Marking Standard and shall be RoHS compliant.

5. Provide Brady B-432 Series, or approved equal by acceptable manufacturer.

6. Faceplates for devices on GFCI-protected circuits shall be factory engraved to read “GFCI”. Refer to Division 26 Section, “Wiring Devices” for additional information.

2.3. EQUIPMENT NAMEPLATES

A. General Nameplate Requirements:

1. Use colors prescribed by ANSI A13.1, NFPA 70 and as follows:

   a. Normal Power System: White lettering on black background.
   b. Emergency Power System: White lettering on red background.

2. Backed with adhesive material formulated for the type of surface, intended use and installed location.

B. Nameplates for Dry, Interior Locations:

1. Engraving stock, melamine 3-layer plastic laminate.

2. Minimum 1/16-inch (1.6-mm) thick for signs up to 20 sq. inches (129 sq. cm)

3. Minimum 1/8-inch (3.2-mm) thick for signs larger than 20 sq. inches.

C. Nameplates for Damp/Wet Interior and Exterior Locations:

1. Weather-resistant, UV Resistant, minimum 1/8-inch (3.2-mm) thick.

D. Refer to Contract Drawings for typical nameplate details.

E. Refer to Paragraph "Equipment Identification Nameplates" under Part 3 of this Section for installation requirements.

2.4. SAFETY SIGNS

A. Comply with 29 CFR, Chapter XVII, Part 1910.45.

2.5. UNDERGROUND LINE WARNING TAPE

A. Non-biodegradable, polyethylene tape, 5 mil minimum thickness and a minimum of 6 inches wide with detectable metallic foil. Provide warning labels on 3 foot centers, colored as follows:

1. Electrical ducts, piping or cable (600V and below) – Red tape with black printed labeling: CAUTION-BURIED ELECTRIC LINE BELOW.

2. Telephone conduits or cable - Orange tape with black printed labeling: CAUTION -BURIED TELEPHONE LINE BELOW.

3. Communications Conduits or Cable – Orange tape with black printed labeling: CAUTION – BURIED COMMUNICATIONS LINE BELOW.

4. Fiber Optic conduits or cable - Orange tape with black printed labeling: CAUTION -BURIED FIBER OPTIC LINE BELOW.

5. Cable TV(CATV) conduits or cable - Orange tape with black printed labeling: CAUTION-BURIED CABLE TV LINE BELOW.

B. Where two (2) or more services share a common ductbank, i.e. telephone and fiber optic, warning tape for each service shall be installed above each service's respective conduit(s).

C. Bury marker tape 12-inches below grade above every ductbank and buried conduit. Refer to Division 26 Section, "Underground Ductbanks" for additional information.

2.6. MISCELLANEOUS IDENTIFICATION PRODUCTS

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

1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength: 50 lb (22.3 kg) minimum.

3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

4. Color: According to color-coding.

B. Paint: Formulated for the type of surface and intended use.

1. Primer for Galvanized Metal: Single-component acrylic formulated for galvanized surfaces.

2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.

3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.

4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3. EXECUTION

3.1. INSTALLATION

A. General:

1. Where mixed voltages are used in one building (e.g., 480 volts, 208 volts), each new piece of equipment, including but not limited to, panelboard(s), transformer(s), safety switches, outlet/pull/junction boxes, etc., on each system must be labeled for voltage in addition to other requirements listed herein.

2. All branch circuit panelboards must be identified with the same designation used in the circuit directory in the Main Switchboard and in Distribution Panelboards.

3. Before attaching labels, clean all surfaces with the label manufacturer's recommended cleaning agent.

4. Install all labels firmly, as recommended by the label manufacturer.

5. Labels attached to wiring device faceplates and electrical equipment shall be installed plumb and neatly on all equipment.

6. Install nameplates parallel to equipment lines.

7. Secure nameplates to equipment fronts unless otherwise noted.

8. Secure nameplate to inside of recessed panelboards in finished locations.

9. Embossed tape will not be permitted for any application.

10. Stenciling is prohibited.

11. Labels: All labels shall be permanent and be machine-generated. NO HANDWRITTEN OR NON-PERMANENT LABELS SHALL BE ALLOWED.

12. Label size shall be appropriate for the conductor/cable size(s), and wiring device faceplate layout. All labels to be used shall be self-laminating, white/transparent vinyl and be wrapped around the cable. Flag type labels are not allowed. The

labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminated over the full extent of the printed area of the label.

B. Panelboard Circuit Directories:

1. Panelboards shall be equipped with equipment nameplates as specified in paragraph “Equipment Identifications Labels” in this Section.

2. Panelboards shall have accurate typed circuit directories indicating exactly what each branch circuit serves.

3. The Contractor shall provide up to date circuit directories in new and existing panelboards, indicating all deletions and additions, and to note the date of all changes on the directory.

4. The circuit directories shall reflect the actual room numbers. Directories indicating the reference room numbers on the contract drawings or in the panelboard schedule shall not be acceptable.

5. The circuit directories shall include the name, address, and contact information for the Electrical/Division 26 Contractor.

6. If at anytime after occupancy the circuit directories are found to be incorrect due to negligence by the installer, then the Contractor shall trace out circuits, and correct the directories at no additional cost to the Owner.

C. Miscellaneous Identification:

1. Individual circuit breakers, switches, and motor starters in distribution panelboards and switchboards: 1/4-inch text (6 mm); identify circuit and load served, including location.

2. Individual circuit breakers, enclosed switches, and motor starters: 1/4-inch text (6 mm); identify load served, circuit and voltage.

3. Junction boxes: 1/4-inch text (13 mm); identify load served, circuit and voltage.

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

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

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

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

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

1. Clean surfaces of dust, loose material, and oily films before painting.

2. Prime surfaces using type of primer specified for surface.

3. Apply one intermediate and one finish coat of enamel.

I. Color Coding of Raceways, Boxes, and Cables:

1. Color coding of conduit and boxes shall not apply in finished spaces. In finished spaces, paint exposed boxes and conduits to match adjacent surfaces, unless otherwise directed by Architect.

2. Junction boxes, pull boxes, and their covers shall be distinctively painted to identify their service.

3. Apply the following colors to the systems listed below:

a. Fire Alarm System: Red.

J. Caution Labels for Boxes and Enclosures: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover. Install label on inside face of door or cover in finished spaces.

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

1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.

2. Concealed Boxes: Plasticized card-stock tags.

3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

L. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground line warning tape located directly above line at 12 inches (150 to 200 mm) below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches (400 mm) overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

M. Feeder and Branch-Circuit Conductors: Color-code throughout the electrical system. Refer to Division 26 Section “Conductors and Cables” for additional requirements.

N. Power-Circuit and Control Wire Identification: Metal tags or aluminum, wraparound marker bands for each conductor, cables, feeders, and power circuits in vaults, panelboard gutters, outlet boxes, junction boxes, pullboxes, switchboard rooms, and at load connections. Identify with branch circuit or feeder number for power and lighting circuits and with control wire number as indicated on equipment manufacturer's shop drawings for control wiring.

1. Legend: 1/4-inch- (6.4-mm-) steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.

2. Tag Fasteners: Nylon cable ties.

3. Band Fasteners: Integral ears.

O. Apply identification to conductors as follows:

1. Conductors to be Extended in the Future: Indicate source and circuit numbers.

2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.

3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

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

1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

Q. Equipment Nameplates

1. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification.

2. Install on each piece of equipment provided with factory installed disconnecting means, e.g. ERV units, where a separate external disconnecting means is not provided under Division 26.

3. Install on each variable frequency drive serving pumps, fans, etc. provided by others where a separate motor controller is not provided under Division 26.

4. Unless otherwise noted, nameplates shall identify equipment designation(s), voltage rating, and source (including source locations).

5. Nameplates for disconnect switches, motor starters, etc…, shall indicate the designation of the load served as the “equipment designation”.

6. In general, nameplates requiring one or two lines of text shall be 1-1/2 inches high. Labels requiring three lines of text shall be 2 inches high. The first line of text, which shall indicate equipment designation/load served, shall utilize ½ inch high lettering. Remaining lines of text, which shall indicate voltage ratings and source information shall utilize ¼ inch high lettering. Refer to the Drawings for nameplate examples.

7. Apply nameplates to each unit of the following categories of equipment:

a. Panelboards.
b. Transformers.
c. Disconnect Switches.
d. Enclosed Circuit Breakers.
e. Motor Controllers.
f. Electrical Cabinets and Enclosures.
g. Lighting Control Panels.
h. Fire Alarm Panel.
i. Access Doors and Panels for Concealed Electrical Items.

R. Conduits Containing Electrical Feeders:

1. All conduits containing electrical feeders shall be identified with W.H. Brady B-500 vinyl cloth pipe markers or equivalent. Systems shall be identified as follows:

a. Labels shall be applied whenever a conduit enters or leaves a switchboard, panelboard, or a junction or pull box, and at each side of penetrations of walls or floors.
b. Apply Y-35 series individual numbers and letters to indicate feeder circuit designation followed by feeder voltage.

S. Fire Alarm: Junction box covers shall be painted red, except in finished spaces where they shall be painted to match adjacent surfaces. Box covers shall have a type written label to read “Fire Alarm” in accordance with requirements of NFPA 72.

T. Surfaces shall be cleaned and painted, if specified, before applying markings.

U. Place markings so that they are visible from the floor.

V. Protect finished identification to ensure that markings are clear and legible when project is turned over to the Owner.

END OF SECTION

DIVISION 26 SECTION 260943
NETWORK LIGHTING CONTROLS
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SECTION 260943 - NETWORK LIGHTING CONTROLS

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 network lighting control system. The system shall include, but not be limited to: server, software, bus supplies, network wall switches, network occupancy sensors, network day-light harvesting sensors, raceway, wire & cable and accessories required to furnish a complete and operational network lighting control system.

B. The network lighting control system shall be a microprocessor based network system. All digital lighting system components shall be tested and cross-listed as compatible to ensure a fully functional system is setup and installed.

C. Furnish and install a complete network lighting control system as described herein and as shown on the plans to be: wired, connected, and left in first class operating condition. Include sufficient control unit(s), wall stations, sensors, wiring, terminations, electrical boxes & cabinets and all other necessary material for a complete operating system.

D. Related Sections:

1. Section 260500 – “Common Work Results for Electrical”: Submittal requirements, general materials, installation requirements, Record Document requirements.

2. Section 260923 – “Lighting Control Devices”: Multipole lighting contactors for controlling exterior lighting.

3. Section 262726 – “Wiring Devices”: Toggle switches, receptacles.

4. Section 265100 – “Interior Lighting”: Interior lighting fixtures, and exterior building-mounted lighting fixtures.

1.3. REFERENCES

A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)

1. C62.41-1991 – Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

2. ANSI C12.20 – Accuracy Standards

B. International Organization for Standardization (ISO) (www.iso.ch):

1. 9001:2000 – Quality Management Systems.

C. National Electrical Manufacturers Association (NEMA) (www.nema.org)

1. WD1 (R2005) - General Color Requirements for Wiring Devices.

2. WD6 – Dimensional Specifications.

D. Underwriters Laboratories, Inc. (UL)www.ul.com:

1. 94 – Flammability Rating

2. 489 (2002) - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

3. UL 498 is the UL Safety Standard for line cord products and wall mounted receptacles.

4. UL498 – Standard for Attachment Plugs and Receptacles.

5. 508 (1999) - Standard for Industrial Control Equipment.

6. UL514C – Standard for Non-metallic Outlet Boxes, Flush Device Boxes, and Covers.

7. 916 – Energy Management Equipment.

8. 924 (2003) - Emergency Lighting and Power Equipment

9. 935 (2005) - Fluorescent Ballasts

10. 1310 – Class 2 Power Units.

11. 1472 (1996) - Solid-State Dimming Controls.

1.4. SYSTEM DESCRIPTION

A. The Lighting control system specified in this section shall provide time-based, sensor-based (both occupancy and daylight), and manual lighting control.

B. The system shall be capable of turning lighting loads on/off as well as dimming lights if lighting load is capable of being dimmed.

C. All control system devices shall be networked together enabling digital communication and shall be individually addressable.

D. The system shall be capable of enabling stand-alone groups of devices to function in some default capacity even if network connectivity to the greater system is lost.

E. System shall facilitate remote operation via a computer connection.

1.5. SUBMITTALS

A. Submit under provisions of Division 01.

B. Specification Conformance Document: Indicate whether the submitted equipment:

1. Meets specification exactly as stated.

2. Meets specification via an alternate means and indicate the specific methodology used.

C. Product Data: Catalog cut sheets with performance specifications demonstrating compliance with specified requirements.

D. Shop Drawings: Provide a complete set of detailed installation drawings specific to this project that include assemblies, schedules and details as required to fully define the installation, testing, startup and other elements necessary to create a complete lighting management control system in accordance with this Specification, including:

1. Schematic (one-line diagram) of system.

2. Large scale floor plans – Indicate location, orientation, and coverage area of each sensor, group designations, etc.

3. Address Drawing – Reflected Ceiling Plan (RCP) indicating all static addresses for all addressable devices, including lighting fixtures, control devices, sensors, relays, network devices, etc.

4. Wiring Diagrams and Schematics – Provide detailed wiring diagrams for each room type. Generic diagrams are not acceptable. Coordinate nomenclature and presentation with a block diagram, and differentiate between manufacturer-installed and field-installed wiring.

E. Samples:

1. Samples showing available color and finish selections for controls shall be submitted to the Architect.

2. Provide one sample of each field-connected device to the Division 26 Contractor for their familiarization.

F. Certifications: Submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

G. Sequence of Operation: To describe how each area operates and how any building wide functionality is described.

1.6. CLOSEOUT SUBMITTALS

A. Start-up and Commissioning Closeout Documentation

1. Lighting Control System Manufacturer to provide enhanced start-up

documentation that details the start-up procedure being performed including a process to follow, details on tests performed and an area that documents any test results.

2. Contractor shall submit startup/commissioning worksheets, which must be completed prior to factory start-up.

B. Software and Firmware Operational Documentation

1. Software operating and upgrade manuals.

2. Program software backup: On a compact disc complete with data files.

3. Device address list.

4. Printout of software application and graphic screens.

C. Record Documents

1. Drawings showing the actual installed hardware and configuration to include: power circuits, control device identification, schedules of control functions, and static addresses for routers, ballasts/drivers, controllers, sensors, and other lighting control devices.

D. Operation and Maintenance Data

1. For lighting controls to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 include the following Software manuals.

a. Adjustments of scene preset controls, fade rates and fade overrides.
b. Operation of adjustable zone controls.
c. Testing and adjusting of emergency lighting and night lighting features.
d. Operation manuals covering the installed lighting management system.
e. A complete set of Record Drawings in both hard copy (minimum 30”x42”) and electronic files in .pdf and .dwg format.

1.7. QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Minimum five (5) years’ experience in manufacture of network lighting control systems.

2. Quality System: Registered to ISO 9001:2000 Quality Standard, including in-house engineering for product design activities.

3. Furnish electrical control equipment for complete installation and single source responsibility of lighting control.

4. Qualified to supply specified products and to honor claims against product presented in accordance with warranty.

5. Manufacturing of all sensors shall occur in the USA. Manufacturing facility must be ROHS compliant.

B. Lighting Control System Components:

1. All applicable products must be UL / CUL Listed or other acceptable national testing organization.

2. Listed by UL specifically for the required loads. Provide evidence of compliance upon request.

3. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to Authorities Having Jurisdiction, and marked for intended use.

4. All sensors and related relays shall be compatible with the specific lighting types controlled.

5. All sensors shall be of the same manufacturer, mixing brands of sensors is not acceptable

6. All sensors and controlled modules connected to more than 50 VAC shall be listed by Underwriters Laboratories.

7. All sensors and related equipment shall be manufactured in the United States of America.

8. All sensors and related equipment shall have a five-year warranty.

C. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing network lighting control systems similar in type and scope to that required for this Project.

1.8. DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Include installation, programming, and maintenance instructions.

1.9. PROJECT CONDITIONS

A. System components shall have ten-year operational life while operating continually at any temperature in an ambient temperature range of 0 degrees C (32 degrees F) to 40 degrees C (104 degrees F) and 90 percent non-condensing relative humidity.

B. Do not install equipment until the above conditions can be maintained in spaces to receive equipment.

C. Do not install products under environmental conditions outside manufacturer's absolute limits.

D. Lighting control system must be protected from dust during installation.

E. Components shall be designed and tested to withstand discharges without impairment of performance when subjected to discharges of 15,000 volts per IEC 801-2.

1.10. WARRANTY

A. Provide manufacturer's warranty covering 5 years from date of purchase with factory startup.

1. Enhanced 5-year limited parts warranty, including:

a. Years 1-2:
i. 100 Percent Replacement Parts for Manufacturer Lighting System Components
ii. 100 Percent Manufacturer Labor Coverage to Troubleshoot and Diagnose a Lighting Issue
iii. First-Available Onsite or Remote Response Time
b. Years 3-5: 100% Replacement Parts Coverage

1.11. EXTRA MATERIALS

A. Make ordering of new equipment for expansions, replacements, and spare parts available to end-user, qualified dealer or installer.

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

1. Occupancy/Vacancy Sensors: Quantity equal to one for every 20 of each type installed, but no fewer than one unit of each type.

2. Daylight Sensors: Quantity equal to one unit for every 20 sensors installed, but no fewer than one unit.

3. Power Pack Relays: Quantity equal to one unit for every 50 modules installed, but no fewer than one of each type.

4. Wall Switches: Quantity equal to one unit for every 30 stations installed, but no fewer than one of each type.

5. Emergency Lighting Interfaces: Quantity of two of each type installed.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

1. nLight/Acuity Controls

2. Lutron Electronics, Inc.

3. Cooper (Eaton) Lighting Controls

4. Encelium

5. Hubbell Lighting Controls

6. Leviton Manufacturing, Co. Inc.

2.2. GENERAL SYSTEM REQUIREMENTS

A. Lighting control system will have: a networked backbone to allow for remote or time based operation, intelligent lighting control devices capable of communicating on a digital network, and a system capable of operating in standalone lighting control zones.

B. Intelligent lighting control devices shall consist of but not be limited to: occupancy sensors, photocell sensors, relays, dimming outputs, low voltage switches, manual switch stations, manual dimming stations, graphic wall control, and intelligent lighting fixtures.

C. System shall be capable of integrating directly with intelligent LED luminaires in a fashion that integration to the system be achieved through the use of interconnecting Cat5 cable.

D. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.

E. All devices within the lighting control system shall be daisy-chained together with Cat5 low voltage cabling in any order

F. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.

G. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or if the management software becomes unavailable.

H. All switching and dimming for a specific lighting zone shall take place within the device located in the zone itself to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.

I. System shall have a primary network control device that is capable of accessing and controlling connected system devices and linking into an Ethernet LAN.

J. System shall have a network communication device that routes communication between control zones and distributes power across up to 8 directly connected zones.

K. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control profiles.

L. System shall be capable of operating a lighting control zone according to a sequence of operation. Operating modes should be utilized only in manners consistent with local code.

1. Auto-On / Auto-Off (via occupancy sensors)

2. Manual-On / Auto-Off

3. Auto-to-Override On

4. Manual-to-Override On

5. Auto On/Predictive Off

6. Multi-Level On (multiple lighting levels per manual button press)

M. Control software shall enable logging of system performance data and presenting information in a web-based graphical format or downloadable .CSV file.

N. Control software shall enable integration with a BMS via BACnet IP.

2.3. CENTRALIZED SYSTEM CONTROL

A. System shall have a centralized processor capable of communicating and controlling downstream system control devices and linking into an Ethernet.

B. Control modules shall be powered by low voltage, and have a backlit LCD display screen.

C. User control shall be made via finger-touch buttons with no moving parts. Buttons shall be capable of being locked for security.

D. Devices shall have RJ-45 ports for connection to other backbone devices or for connection directly to lighting control zones.

E. Devices shall automatically detect all downstream devices.

F. Devices shall have a standard and astronomical internal time clock capable of providing time based command to all devices downstream of control module.

G. Devices shall have an RJ-45 10/100 BaseT Ethernet connection.

H. Devices shall be capable of using a dedicated or DHCP assigned IP address.

2.4. CENTRALIZED COMMUNICATION DEVICES

A. Devices shall have multiple RJ-45 ports.

B. Devices shall be capable of aggregating communication from multiple lighting control zones for purpose of minimizing backbone wiring requirement back to centralized system control.

C. Devices shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a Cat5 connection.

D. Devices shall be capable of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

2.5. POWER PACKS

A. Power packs shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Power supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary relay packs shall switch low voltage circuits only.

B. Power packs shall accept and switch 120VAC or 277 VAC, be plenum rated, and provide Class 2 power for multiple sensors.

C. Power packs shall securely mount to junction location through a threaded ½ inch chase nipple. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads.

D. Power packs shall incorporate a Class 1 relay and an AC electronic switching device. The AC electronic switching device shall make and break the load, while the relay shall carry the current in the on condition. This system shall provide full 20 Amp switching of all load types, and be rated for 400,000 cycles.

E. Power packs for emergency lighting control shall be UL924 listed.

F. Power packs for plug-load control shall be rated for switching 20 amperes.

G. All applicable products must be UL / CUL Listed or other acceptable national testing organization.

2.6. OCCUPANCY SENSORS

A. Occupancy sensor system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.

B. Sensors shall utilize passive infrared technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions.

C. For applications where a second method of sensing is necessary to adequately detect maintained occupancy, sensors with an additional technology shall be used.

D. Sensor shall be capable of mounting in multiple locations:

1. Ceiling Mount
2. Corner Mount
3. Wall Mount with on/off switch
4. Fixture Mount

E. Sensor shall be available with different sensing technologies:

1. Passive Infrared (PIR).
2. Microphonics

3. Ultrasonic

F. Low voltage sensors shall receive communication and Class 2 low voltage power via standard Cat5 low voltage cabling with RJ-45 connectors.

G. Line voltage sensors shall be capable of switching 120/277 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, and ¼ HP motors.

H. Sensors shall turn lights on only upon infrared detection.

I. Sensors shall indicate detected motion via a red LED.

J. Sensor controls shall be behind cover to resist tampering.

K. Sensors shall have optional features for on/off photocell control, automatic dimming control photocell, high/low occupancy based dimming, and usage in low temperature/high humidity environments.

L. Sensors with dimming can control 0-10 VDC dimmable ballasts by sinking up to 20 mA of Class 2 current.

M. The occupancy sensor system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.

2.7. DAYLIGHT CONTROLS

A. Low voltage photocell shall accept 12 to 24 VAC or VDC and provide a relay for interface with remote switching system. Sensors shall interface with occupancy sensors, directly with power pack or other system as shown. Sensors shall control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of class 2 current.

B. Low voltage dimming sensors set point shall be automatically calibrated through the sensor's microprocessor by initiating the "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.

C. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.

D. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space.

E. Dual zone option shall be available for photocell, dimming, or combination units. The second zone shall be controlled as an "offset" from the primary zone and shall be the zone farthest from the natural light source.

F. Line voltage versions of the above described photocell and combination photocell/dimming sensors shall be capable of switching both 120 VAC and 277 VAC and run off of 50/60 Hz power. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, and ¼ HP motor load.

G. Line voltage versions of the above described dimming sensors shall be capable of powering

off 120/277 VAC.

2.8. WALL SWITCHES, DIMMERS, AND SCENE CONTROLLERS

A. All switches shall recess into a single-gang switch box and fit a standard decorator style opening.

B. Communication and low voltage power shall be delivered to each device via standard Cat5 low voltage cabling with RJ-45 connectors.

C. All switches shall provide toggle (on/off) control. Dimming control shall be provided where indicated.

D. Devices with mechanical push-buttons shall have custom button labeling, as detailed/scheduled on the Drawings.

E. Devices with a single on button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusions as to which of two buttons controls which load is eliminated.

F. Devices shall have two to four buttons for selecting programmable lighting control profiles or acting as on/off switches.

G. Devices shall be capable of selecting a lighting profile be run by the system's upstream processor so as to implement selected lighting profile across multiple zones.

H. Refer to details and the "Network Wall Switches Schedule" of the Contract Drawings for specific requirements.

2.9. RELAY AND DIMMING PANELS

A. Panel shall incorporate up to 16 normally closed latching relays at 120/277 VAC or 2 dual phase 208/480 VAC relays.

B. Relays shall be rated to switch up to 30A ballast loads at 277 VAC.

C. Panel shall be capable of 0-10 VDC dimming for each zone.

D. Power shall be powered from an integrated 120/277 VAC supply.

E. Panel shall have two (2) RJ-45 ports and be capable of operating as a networked device.

2.10. AUXILIARY INPUT / OUTPUT DEVICES

A. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.

B. Devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current.

C. Devices shall have an input that read a 0-10 VDC signal from an external device.

D. Device shall have a switch input that can interface with either a maintained or momentary switch and run a switch event, or run a local/remote control profile.

2.11. BUILDING MANAGEMENT SYSTEM COMPATIBILITY

A. System shall provide a BACnet IP gateway as a downloadable software plug-in to its management software. No additional hardware shall be required.

B. BACnet IP gateway software shall communicate information gathered by networked system to other building management systems

C. BACnet IP gateway software shall translate and forward lighting relay and other select control commands from BMS system to networked control devices.

2.12. SYSTEM ENERGY ANALYSIS & REPORTING SOFTWARE

A. System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.

B. Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.

C. An “Energy Scorecard” shall be display that shows calculated energy savings in dollars, KWHr, or CO2.

D. Software shall calculate the allocation of energy savings to different control measures.

E. Energy savings data shall be calculated for the system as a whole or for individual zones.

F. User shall be able to customize the baseline run-time hours for a space.

G. User shall be able to customize up to four time-of-day billings rates and schedules.

2.13. MANAGEMENT SOFTWARE

A. Every device parameter shall be available and configurable remotely from the software.

B. The following status monitoring information shall be made available from the software for all devices for which is applicable:

1. Current Occupancy Status

2. Current PIR Status

3. Current Microphonic Status

4. Remaining Occupancy Time Delay

5. Current Photocell Reading

6. Current Photocell Inhibiting State

7. Photocell Transitions Time Remaining

8. Current Dim Level

9. Device Temperature

10. Device Delay Status

C. The following device identification information shall be made available via the software:

1. Model Number

2. Model Description

3. Serial Number

4. Manufacturing Date Code

5. Custom Label

6. Parent Network Device

D. Software shall provide at least three permission levels for users.

PART 3. EXECUTION

3.1. EXAMINATION

A. Examine substrate areas and conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Lighting Management System.

B. Examine rough-in for the network lighting controls to verify actual locations of conduit connections before equipment installation.

C. Examine walls, floors, ceilings, etc. for suitable conditions where network lighting control equipment will be installed.

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

3.2. INSTALLATION

A. Install equipment in accordance with manufacturer's installation instructions.

B. Provide complete installation of system in accordance with Contract Documents.

C. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.

D. Secure equipment to building structural elements and support according to requirements of Division 26 Section "Hangers and Supports".

E. Define each dimmer's/relay's load type, assign each load to a zone, and set control functions.

F. Ensure that daylight sensor placement minimizes sensors view of electric light sources; ceiling mounted and fixture-mounted daylight sensors shall not have direct view of luminaires.

G. Label all wiring, cables and enclosures in accordance with Division 26 Section "Electrical Identification".

H. Systems Integration:

1. Equipment Integration Meeting Visit

a. Facility Representative to coordinate meeting between Facility Representative, Lighting Control System Manufacturer and other related equipment manufacturers to discuss equipment and integration procedures.

I. Wiring Method:

1. Bus control wire shall be run in accordance with the requirements of this spec, local jurisdiction requirements, or Manufacture's written requirements whichever is more stringent.

2. Conductors to Class 2 occupancy sensors or photo-sensors not exceeding 12 feet may be installed in accordance with NEC Article 725 for Class 2 circuits and the support requirements of this Section.

3. Class 2 control cable over 12 feet in length shall be run in conduit or bundled and run in accordance with communication cable requirements.

4. Free-run Class 2 cable shall be supported at a minimum of every 6 feet and shall be run above ductwork and other equipment at the truss level to reduce the exposure to damage.

5. Cable supports shall use double wire ties or equivalent methods that prevent direct contact between the cable and sharp and/or hard surfaces such as running thread rods, pipe supports, and suspended ceiling wires.

6. Cable supports shall not pinch or overly tighten the cable.

7. Cable shall not be supported by ductwork, ceiling tiles, or other equipment.

8. Connections to sensors and other devices shall be strain relieved to the device or a nearby support.

9. When mounted in a ceiling tile the cable shall include at least 6 feet of coiled cable to allow tiles to be relocated.

10. Comply with manufacturer's written instructions for wiring installation or this spec whichever is more stringent.

11. Install bus wire with the minimum number of splices.

J. Wiring Within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to equipment manufacturer's written instructions.

K. Surge Protection: Install field-mounted transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

L. Equipment Grounding: Provide low-impedance “hard” copper earth grounding to ballasts, fixtures, and control mounting boxes in accordance with ballast, lamp, and control manufacturer’s requirements. Floating fixture strike plates and high-impedance “safety grounds” are generally not acceptable and standard UL listed safety grounds may not be sufficient.

M. 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.

3.3. IDENTIFICATION

A. Identify components, and power and control wiring in accordance with Division 26 Section "Electrical Identification”.

B. Identify all ceiling mounted controls in blank covered boxes with network number, device address, and type of control located in box.

C. Label each network wiring pair within 6 inches of connection to control network bus supply or termination block. Each control network wire pair shall be labeled in accordance with Division 26 Identification section and shall include the electrical power panel name and circuit number with which the wire pair is pulled.

3.4. SERVICE AND SUPPORT

A. Startup and Programming

1. Provide factory certified field service engineer to make minimum of three site visits to ensure proper system installation and operation under following parameters

a. Qualifications for factory certified field service engineer:
   i. Minimum experience of 2 years training in the electrical/electronic field.
   ii. Certified by the equipment manufacturer on the system installed.
b. Make first visit prior to installation of wiring. Review the following:
   i. Low voltage wiring requirements.
   ii. Separation of power and low voltage/data wiring.
   iii. Wire labeling.
   iv. Lighting Management Panel locations and installations.
   v. Control locations.
   vi. Computer jack locations.

vii. Load circuit wiring.
viii. Network wiring requirements.
ix. Connections to other equipment and other Lutron equipment.
x. Installer responsibilities.
xi. Power Panel locations.

c. Make second visit upon completion of installation of Network Lighting Control System:
i. Verify connection of power wiring and load circuits.
ii. Verify connection and location of controls.
iii. Energize Lighting Management Panels and download system data program.
iv. Address devices.
v. Verify proper connection of panel links (low voltage/data) and address panel.
vi. Download system panel data to dimming/switching panels
vii. Check dimming panel load types and currents and supervise removal of by-pass jumpers.
viii. Verify system operation control by control.
ix. Verify proper operation of manufacturers interfacing equipment.
x. Verify proper operation of manufacturers supplied PC and installed programs.
xi. Configure initial groupings of ballast for wall controls, daylight sensors and occupant sensors.
xii. Initial calibration of sensors.
xiii. Obtain sign-off on system functions.

d. Make third visit to demonstrate and educate Owner's representative on system capabilities, operation and maintenance. See requirements below.

2. Startup

a. Software configuration
i. Naming and association of areas and lighting zones.

b. After Hours Start-up
i. Provide factory certified Field Service Engineer to perform manufacturer's start-up procedures outside normal working hours (Monday through Friday, 7a.m. to 5 p.m.)

B. Training of customer representatives for Lighting Management Software

C. Provide factory direct technical support hotline 24 hours per day, 7 days per week.

3.5. FIELD QUALITY CONTROL

A. Manufacturer Services

1. Aim and Focus Visit

a. Facility Representative to coordinate on-site meeting with Lighting Control System Manufacturer and Architect/Engineer to make required lighting adjustments to the system for conformance with the Architect/Engineer's original design intent.

B. Complete installation and startup checks in accordance with manufacturer's written instructions to include the following:

1. Prefunction - Compliance inspection of all materials, controls, light fixtures.

2. Activate light fixtures prior to control system activation and verify that all light sources are operating at 100%.

3. Test that control bus wiring is free of wire-ground and wire-wire shorts and AC line voltage before connecting to the Bus Supply.

C. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.

D. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

E. Reports: Prepare written reports of tests, inspections, verifications and observations indicating and interpreting results. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments

F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

G. Verify normal operation of each fixture after installation.

H. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to backup source and retransfer to normal.

I. If adjustments are made to lighting control system, retest to demonstrate compliance with standards.

3.6. DEMONSTRATION & TRAINING

A. Training Visit

1. Lighting Control System Manufacturer to provide 2 days (minimum 12 hours) additional on-site system training to site personnel.

B. On-Site Walkthrough

1. Lighting Control System Manufacturer to provide a factory certified Field Service Engineer to demonstrate system functionality to the Commissioning Agent.

C. Video Recordings

1. Record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

2. At beginning of each training module, record each chart containing learning objective and lesson outline.

3. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Architect and Owner.

4. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.

5. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.

6. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

3.7. MAINTENANCE

A. Capable of providing on-site service support within 24 hours anywhere in continental United States.

B. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system startup.

C. System Optimization Visit

1. Lighting Control System Manufacturer to visit site six (6) months after system start-up to evaluate system usage and discuss opportunities to make efficiency improvements that will fit with the current use of the facility.

END OF SECTION

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TRANSFORMERS
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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 dry-type distribution and high harmonic/non-linear load transformers rated 1000 V, and less.

1.3. SUBMITTALS

A. Product Data: Include data on features, components, ratings, dimensions, weight, and performance for each type of transformer specified. Include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features.

B. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.

C. Product Certificates: Signed by manufacturers of transformers certifying that the products furnished comply with requirements.

D. Field Test Reports: Indicate and interpret test results for tests specified in Part 3 of this Section.

E. Maintenance Data: For transformers to be included in the Operation and Maintenance Manuals specified in Division 01 and Division 26 Section, “Common Work Results for Electrical”.

F. Project Record Documents: Record actual transformer locations.

1.4. QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to requirements specified in Division 01 Section “Quality Control”, an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907; or shall be a full-member company of the International Electrical Testing Association.

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 of this Section.

B. Listing and Labeling: Provide transformers specified in this Section that are listed and

labeled.

1. The Terms Listed and Labeled: As defined in NFPA 70, Article 100.

2. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory as defined in OSHA Regulation 1910.7.

1.5. DELIVERY, STORAGE, AND HANDLING

A. 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 is not in a space that is continuously under normal control of temperature and humidity.

B. Store and protect equipment in a dry location with uniform temperature. Cover ventilation openings to keep dust out.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, supply equipment from one of the following manufacturers: No other manufacturers are acceptable.

1. Square D Company. (Basis of Design)

2. Eaton/Cutler-Hammer.

3. General Electric (GE)

2.2. TRANSFORMERS, GENERAL REQUIREMENTS

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

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous aluminum windings without splices, except for taps.

D. Coil Conductors: Individually insulate secondary conductors and arrange to minimize hysteresis and eddy current losses at harmonic frequencies.

E. Internal Coil Connections: Brazed or pressure type.

F. Enclosure: Class complies with NEMA 250 for the environment in which installed. Comply with NEMA ST 20.

G. Nameplates: Include transformer connection data and overload capacity based on rated allowable temperature rise.

H. Basic Impulse Level: 10 kV for transformers less than 300 kVA.

2.3. ENERGY EFFICIENT GENERAL PURPOSE TRANSFORMERS

A. Description

1. Dry-Type distribution transformers for general loads, single and/or three-phase, with primary and secondary voltages of 600 V and less and capacity ratings 15kVA through 750kVA.

B. Standards

1. Transformers 750kVA and smaller shall be listed by Underwriters Laboratories.

2. Conform to the requirements of ANSI/NFPA 70.

3. Transformers are to be manufactured and tested in accordance with NEMA ST20 and UL 1561.

4. Transformers shall be low loss type with minimum efficiencies per US Department of Energy (DOE) 2016 Standards, as defined in the Code of Federal Regulations, 10 CFR 431.192.

C. Manufacturers

1. Approved manufacturers shall be registered firms in accordance with ISO 9001:1994 SIC3612 (US); which is the design and manufacture of low voltage dry type power, distribution and specialty transformers.

D. Ratings Information

1. All insulating materials are to exceed NEMA ST20 standards and be rated for 220 degrees C UL component recognized insulation system.

2. Transformers 15kVA and larger shall be 150 degrees C temperature rise above 40 degrees C ambient. Transformers 25kVA and larger shall have a minimum of 4 – 2.5% full capacity primary taps. Exact voltages and taps to be as designated on the plans or the transformer schedule.

3. The maximum temperature of the top of the enclosure shall not exceed 50 degrees C rise above a 40 degrees C ambient.

E. Construction

1. Transformer coils shall be of continuous wound construction and shall be impregnated with non-hygroscopic, thermosetting varnish.

2. All cores to be constructed with low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturated point to prevent core overheating. Cores for transformers greater than 500kVA shall be clamped utilizing insulated bolts through the core laminations to ensure proper pressure throughout the length of the core. The completed core and coil shall be bolted to the base of the enclosure, but isolated by means of rubber vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and

the enclosure except for a flexible safety ground strap. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.

3. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.

4. The transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. The entire enclosure shall be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use. The coating color shall be ANSI 49.

F. Sound Levels

1. Sound levels shall be warranted by the manufacturer not to exceed the following: 15 to 50 KVA - 45dB; 51 to 150kVA – 50dB; 151 to 300kVA – 55dB; 301 to 500kVA – 60dB; 501 to 700kVA – 62dB; 701 to 1000kVA – 64dB; 1001 to 1500kVA – 65dB; 1501 to 2000kVA – 66dB

2.4. HIGH HARMONIC LOAD (K-RATED) TRANSFORMERS

A. Description

1. Dry type distribution transformers for non-linear loads, single and/or three phase, primary and secondary voltage of 600V and less and capacity ratings of 15kVA through 750kVA.

B. Standards

1. Transformers 750kVA and smaller shall be listed by Underwriters Laboratories.

2. Conform to the requirements of ANSI/NFPA 70.

3. Transformers are to be manufactured and tested in accordance with NEMA ST20 and UL1561.

4. Transformers shall be low loss type with minimum efficiencies per US Department of Energy (DOE) 2016 Standards, as defined in the Code of Federal Regulations, 10 CFR 431.192.

C. Manufacturers

1. Approved manufacturers shall be registered firms in accordance with ISO9001:1994 SIC 3612 (US); which is the design and manufacture of low voltage dry type power, distribution and specialty transformers.

D. Ratings Information

1. All insulating materials are to exceed NEMA ST20 standards and be rated for 220

degrees C UL component recognized insulation system.

2. Neither the primary nor the secondary temperature shall exceed 220 degree C at any point in the coils while carrying their full rating of non-sinusoidal load. Transformers are to be UL listed and labeled for [K-9][K-13] as defined as the sum of fundamental and harmonic 1 h per UL 1561. Transformers evaluated by the UL K factor evaluation shall be listed for [115] [150] degrees C average temperature rise. [K factor listed transformers rated at 150 degrees C rise shall not be acceptable.]

3. K factor rated transformers shall have an impedance range of 3% to 5% and shall have a minimum reactance of 2% in order to help reduce neutral current when supplying loads with large amounts of third harmonic current.

4. Transformers 15kVA and larger shall have a minimum of 6 – 2.5% full capacity primary taps for 480V primaries and a minimum of 2 – 5% fully capacity taps for 208V primaries. Exact voltage and taps to be as designated on the plans or the transformer schedule.

5. The maximum temperature of the top of the enclosure shall not exceed 50 degrees C rise above a 40 degrees C ambient.

E. Construction

1. Transformer coils shall be of continuous wound construction and shall be impregnated with non-hygroscopic, thermosetting varnish.

2. All cores to be constructed with low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point to prevent core overheating. The core laminations shall be clamped together with steel angles. The completed core and coil shall be bolted to the base of the enclosure but isolated by means of rubber vibration absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure except for a flexible safety ground strap. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.

3. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.

4. The transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. The entire enclosure shall be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use. The coating color shall be ANSI 49.

5. Transformers shall be supplied with quality, full width electrostatic shields resulting in a maximum effective coupling capacitance between primary and secondary of 33 picofarads. With transformers connected under normal, loaded operating conditions, the attenuation of line noise and transients shall equal or

exceed the following limits:

a. Common Mode: 0 to 1.5kHZ – 120dB; 1.5kHZ to 10kHZ – 90dB; 10kHZ to 100kHZ – 65dB; 100kHZ to1MHZ – 40dB
b. Transformer Mode: 1.5kHZ to 10kHZ – 52dB; 10kHZ to 100kHZ – 30dB; 100kHZ to 1MHZ 30dB

6. Sound Levels

a. Sound levels shall be warranted by the manufacturer not to exceed the following:
i. 15 to 50kVA – 45dB; 51 to 150kVA – 50dB; 151 to 300kVA – 55dB; 301 to 500kVA – 60dB; 501 to 700kVA – 62dB; 701 to1000kVA – 64dB.

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. FINISHES

A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

B. Outdoor Units: Comply with ANSI C57.12.28.

PART 3. EXECUTION

3.1. INSTALLATION

A. Comply with safety requirements of IEEE C2.

B. Arrange equipment to provide adequate spacing for access and for circulation of cooling air.

C. Identify transformers and install warning signs according to Division 26 Section “Electrical Identification”.

D. 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.

E. Install transformers in accordance with NECA SI, as indicated on the Drawings, and Manufacturer's published instructions, at locations as indicated on the Drawings.

1. Use Manufacturer-approved mounting brackets for transformers supported from building structure.

2. Securely anchor transformers to concrete pad for floor-mounted transformers.

3. Provide working clearances in conformance with NFPA 70.

4. Provide both, primary and secondary protection using fuses or circuit breakers as indicated on the Drawings.

F. Set transformers plumb and level.

G. Use minimum two (2) foot length flexible conduit for connections to transformer case. Make conduit connections to side panel of enclosure.

H. Mount transformers on vibration isolating pads suitable for isolating transformer noise from building structure.

I. Provide minimum 4-inch high concrete pad for floor-mounted transformers. Refer to Division 26 Section, "Common Work Results for Electrical" for installation requirements.

J. Verify mounting supports are properly sized and located, including concealed bracing in walls.

3.2. GROUNDING

A. Separately Derived Systems: Comply with requirements of National Electrical Code Article 250.30 – The grounding electrode conductor (GEC) connection shall be made at the source of the separately derived system (i.e. the transformer) in the transformer enclosure, where the system bonding jumper shall also be installed. Provide supply-side bonding jumper from transformer to first disconnecting means or overcurrent device after the transformer.

B. Comply with Division 26 Section "Grounding and Bonding" for materials and installation requirements.

C. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

3.3. 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 transformers using Manufacturer's approved methods and materials.

3. Verify that transformer nameplates are installed and accurate.

4. Verify that transformer phase identification nameplates are installed.

5. Verify that transformer 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 transformer enclosure. Securing ground bar to vent opening is not acceptable.

B. Transformer Electrical Tests: Include the following minimum inspections and tests according to manufacturer's written instructions to ensure transformer is operational within industry and manufacturer's tolerances, is installed according to the Contract Documents, and is suitable for energizing. Comply with IEEE C57.12.91 for test methods and data correction factors.

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. Insulation Resistance Testing: Perform megohm meter tests of primary and secondary winding to winding and winding to ground, as follows:

   a. Minimum Test Voltage: 1000 Vdc.
   b. Minimum Insulation Resistance: 500 megohms.
   c. Duration of Each Test: 10 minutes.
   d. Temperature Correction: Correct results for test temperature deviation from 20 degrees C standard.
   e. Compare test results with specified performance or manufacturer’s data. Correct deficiencies identified by tests and retest.
   f. 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.

5. Infrared Scanning: Perform an infrared scan of all electrical connections in each transformer, 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.

6. 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.

3.4. 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.

3.5. ADJUSTING

A. Record transformer secondary voltages at each transformer for at least 48 hours of typical occupancy. 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 test report recording output voltages and tap settings.

END OF SECTION

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SWITCHBOARDS, CIRCUIT BREAKER TYPE - MODIFICATIONS
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SWITCHBOARDS

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 modifications to existing circuit breaker type service and distribution switchboards rated 600 volts and less. Modifications include, but are not limited to the following:

1. Provide new circuit breaker(s) in existing switchboard(s).

B. Provide design and engineering, labor, material, equipment, related services and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for switchboards as required for the complete performance of the work, and as shown on the Drawings and as specified herein.

C. Related Sections include the following:

1. Division 26 Section "Common Work Results for Electrical" for general and installation materials and methods.

2. Division 26 Section "Electrical Identification" for identification materials for labeling switchboards, including, but not limited to equipment nameplates.

1.3. REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

B. American Society of Testing Materials (ASTM):

1. ASTM E 329, "Standard Specification for Agencies Engaged in the Testing and/or inspection of Materials Used in Construction."

C. Federal Specifications (FS):

1. FS W-C-375, "Circuit Breakers, Molded Case, Branch Circuit and Service."

D. Institute of Electrical and Electronics Engineers (IEEE):

1. ANSI/IEEE C57.13, "Standard Requirements for Instrument Transformers."

E. InterNational Electrical Testing Association (NETA):

1. NETA ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems."

F. International Organization for Standardization (ISO):

1. ISO 9001, "Quality Management Systems – Requirements."

G. National Electrical Contractors Association (NECA):

1. NECA 400, "Standard for Installing and Maintaining Switchboards."

H. National Electrical Manufacturers Association (NEMA):

1. NEMA KS 1, "Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)."

2. NEMA PB 2.1, "General Instructions for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less."

I. National Fire Protection Association (NFPA):

1. NFPA 70, "National Electrical Code."

2. NFPA 70B, "Electrical Equipment Maintenance."

3. NFPA 70E, "Standard for Electrical Safety in the Workplace."

J. Underwriters Laboratories, Inc. (UL):

1. UL 98, "Standard for Enclosed and Dead-Front Switches."

2. UL 489, "Standard for Molded-Case Circuit Breakers and Circuit Breaker Enclosures."

3. UL 891, "Standard for Dead-Front Switchboards."

1.4. SUBMITTALS

A. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications.

1. Submit product data for each type of switchboard, overcurrent protective device, accessory, and component indicated.

2. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: Include the following for each switchboard:

1. Dimensioned Plans: Show dimensioned front and side enclosure plans and elevations, including required clearances and service space.

2. Component and Device Lists: Show tabulations of installed devices, features and voltage rating.

3. Single-Line Diagram: Show main- and branch-bus current ratings and short-time and short-circuit ratings of switchboards.

4. Wiring Diagrams: Submit wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturer-installed and field-installed wiring, and between components provided by the manufacturer and those provided by others.

5. Nameplate Legends: Submit sample equipment nameplates for switchboards and for individually-mounted and/or group-mounted branch devices.

C. Quality Control Submittals: Submit field quality control test reports.

D. Contract Closeout Submittals:

1. Operation and Maintenance Data: Submit operation and maintenance data for switchboards to include in operation and maintenance manuals specified in Division 01.

2. Warranty Data: Submit manufacturer's standard warranty documents.

3. Project Record Data: Record actual locations of switchboards, indicating actual feeder circuit arrangement.

1.5. QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of switchboards of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of 20 years. The manufacturer shall be ISO 9001 certified and shall be designed to internationally accepted standards.

B. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing switchboards similar in type and scope to that required for this Project.

C. Testing Agency Qualifications: In addition to the requirements specified in Division 01 Section Quality Control, an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full-member company of the International Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3 of this Section.

D. Listing and Labeling: Provide switchboard assemblies 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 as defined in OSHA Regulation 1910.7.

1.6. DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.

B. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path.

C. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

D. Handle switchboards according to NEMA PB 2.1. Use only factory-installed lifting provisions.

1.7. PROJECT CONDITIONS

A. Environmental Requirements: Do not install switchboards until space is enclosed and weatherproof, wet work space is completely and nominally dry, overhead work is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.

B. Verify Dimensions: Verify NEC and all Code clearance requirements by field measurements. Locate switchboard to meet installation tolerances.

C. Determine suitable path for moving switchboard into place considering Project conditions.

D. Revise locations and elevations from those indicated as required to suit Project conditions.

1.8. WARRANTY

A. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for the lesser of one (1) year from date of installation or eighteen (18) months from date of purchase.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Acceptable Manufacturers: Provide equipment from the following manufacturer: No other manufacturers are acceptable.

1. Square D Company. (Basis of Design)

2.2. MANUFACTURED UNITS

A. Front-Accessible Switchboard: Front and rear aligned, with features as follows:

1. Branch Devices: Fixed, panel-mounted plug-on devices rated 1200 amperes and less.

B. Ratings: Provide nominal system voltage, amperage, and short-circuit current ratings as indicated.

2.3. FABRICATION AND FEATURES

A. Enclosure: Provide steel enclosure, in compliance with UL 891, Type as indicated on the Drawings, unless otherwise indicated to meet environmental conditions at installed location as indicated below:

1. Dry, Interior Locations: NEMA 1

2.4. OVERCURRENT PROTECTIVE DEVICES

A. Overcurrent protective devices include, but are not limited to, the following:

1. Electronic trip circuit breakers.

2. Thermal magnetic circuit breakers.

B. Molded-Case Circuit Breaker Features and Accessories:

1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.

2. Lugs: Mechanical style, suitable for quantity, size/gauge, and material of conductors indicated.

3. Application Listing: Appropriate for application, including switching fluorescent lighting loads (Type SWD) or heating, air-conditioning, and refrigerating equipment (Type HACR).

4. Handle Padlock Attachment: All circuit breakers in switchboards shall be equipped with fixed handle padlock attachment to allow padlocking the circuit breaker in the ON or OFF position.

2.5. DISTRIBUTION SECTION DEVICES – GROUP MOUNTED CIRCUIT BREAKERS THROUGH 1200A

A. General Requirements

1. Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.

2. Circuit breaker(s) equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breaker(s) shall be held in mounted position

by a self-contained bracket secured to the mounting pan by fasteners. Circuit breaker(s) of different frame sizes shall be capable of being mounted across from each other.

3. Line side circuit breaker connections are to be jaw type.

B. Electronic Trip Molded Case Circuit Breakers

1. Electronic trip, molded case, 80% rated circuit breaker(s) with Micrologic® interchangeable ammeter trip unit and the following time/current response adjustments:

a. Long Time Pickup
b. Long Time Delay
c. Short Time Pickup
d. Short Time Delay
e. Instantaneous Settings

2. All adjustments shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.

3. Circuit breaker trip system shall be micro-processor based true RMS sensing designed with sensing accuracy through the thirteenth (13th) harmonic.

4. Sensor ampere trip ratings shall be as indicated on the Drawings.

5. Local visual trip indication for overload, short circuit trip occurrences.

6. Long time pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.

C. Thermal Magnetic Circuit Breakers

1. Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.

2. Ampere ratings shall be as shown on the Drawings.

3. Ampere interrupting capacity ratings shall be as shown on the Contact Drawings, but not less than 35,000 AIC RMS symmetrical amperes at rated voltage.

2.6. IDENTIFICATION

A. Nameplates: Engraved nameplates with 1/4" high white lettering shall be furnished for all new circuit breakers installed in existing switch.

B. Refer to Division 26 Section "Electrical Identification" for additional information.

PART 3. EXECUTION

3.1. CONNECTIONS

A. Connect new circuit breakers to wiring systems and to ground as indicated and instructed by manufacturer. Tighten electrical connectors and terminals, including screws and bolts, according to manufacturer's published torque tightening values. Use a calibrated torque wrench. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Neutral and ground conductors shall be isolated and terminated only at their respective bus bars. There shall only be one neutral-ground connection in service-entrance equipment by means of a removable main bonding jumper. Neutral and ground terminations at one bus bar shall not be acceptable.

3.2. IDENTIFICATION

A. Identify new circuit breakers as specified in Division 26 Section “Electrical Identification”.

B. Contractor shall indicate final arrangement and modifications of switchboard on record drawings.

3.3. FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection: Include the following inspections and related work:

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and switchboard schedules.

2. Clean devices using Manufacturer’s approved methods and materials.

3. Verify that switchboard nameplates are installed and accurate.

4. Perform visual and mechanical inspection and related work for over-current protective devices.

3.4. CLEANING

A. Upon completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.5. PROTECTION

A. Provide final protection and maintain conditions in a manner that shall ensure that the switchboard(s) shall be without damage at time of Substantial Completion.

END OF SECTION

DIVISION 26 SECTION 262416
PANELBOARDS
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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 lighting and power panelboards and associated auxiliary equipment rated 600 V and less.

B. Provide design and engineering, labor, material, equipment, related services and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for panelboards as required for the complete performance of the work, and as shown on the Drawings and as specified herein.

C. Panelboards shall be fully rated for the AIC identified on the panelboard schedules on the Contract Drawings.

D. Related Sections include the following:

1. Division 26 Section “Common Work Results for Electrical” for general materials and installation methods.

2. Division 26 Section “Electrical Identification” for labeling materials.

1.3. ALTERNATES

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

1.4. REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

B. American Society of Testing Materials (ASTM):

1. ASTM E 329, “Standard Specification for Agencies Engaged in the Testing and/or inspection of Materials Used in Construction.”

C. Federal Specifications (FS):

1. FS W-C-375, “Circuit Breakers, Molded Case, Branch Circuit and Service.”

D. International Electrical Testing Association (NETA):

1. NETA ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems."

E. International Organization for Standardization (ISO):

1. ISO 9001, "Quality Management Systems – Requirements."

F. National Electrical Contractors Association (NECA):

1. NECA 407, "Standard for Installing and Maintaining Panelboards."

G. National Electrical Manufacturers Association (NEMA):

1. NEMA PB 1, "Panelboards."

2. NEMA PB 1.1, "General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."

3. NEMA PB 1.2, "Application Guide for Ground Fault Protective Devices."

H. National Fire Protection Association (NFPA):

1. NFPA 70, "National Electrical Code."

2. NFPA 70B, "Electrical Equipment Maintenance."

3. NFPA 70E, "Standard for Electrical Safety in the Workplace."

I. Underwriters Laboratories, Inc. (UL):

1. UL 50, "Standard for Enclosures for Electrical Equipment."

2. UL 67, "Standard for Panelboards."

3. UL 489, "Standard for Molded-Case Circuit Breakers and Circuit Breaker Enclosures."

4. UL 943, "Standard for Ground-Fault Circuit Interrupters."

5. UL 1449, "Standard for Surge Protective Devices."

1.5. SUBMITTALS

A. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications.

1. Submit product data for each type of panelboard, overcurrent protective device, surge protective device, accessory, and component indicated.

2. Include dimensions and manufacturer's technical data on features, performance,

electrical characteristics, ratings, and finishes of individual protective devices and auxiliary components.

B. Shop Drawings: Include the following for each panelboard:

1. Dimensioned Plans: Show dimensioned enclosure plans and elevations, including required clearances and service space.

2. Component and Device Lists: Show tabulations of installed devices, features and voltage rating.

3. Single-Line Diagram: Show main- and branch-bus current ratings and short-time and short-circuit ratings of panelboards.

4. Wiring Diagrams: Submit wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturer-installed and field-installed wiring, and between components provided by the manufacturer and those provided by others.

5. Nameplate Legends: Submit sample equipment nameplates for panelboards.

C. Quality Control Submittals: Submit field quality control test reports certified by testing agency.

D. Contract Closeout Submittals:

1. Operation and Maintenance Data: Submit operation and maintenance data for panelboards to include in operation and maintenance manuals specified in Division 01.

2. Warranty Data: Submit manufacturer's standard warranty documents.

3. Panelboard Circuit Directories: For installation in panelboards. Submit final versions after load balancing.

4. Project Record Data: Record actual locations of panelboards, indicating actual branch circuit arrangement.

1.6. QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of panelboards of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of 20 years. The manufacturer shall be ISO 9001 certified and shall be designed to internationally accepted standards.

B. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing panelboards similar in type and scope to that required for this Project.

C. Testing Agency Qualifications: In addition to the requirements specified in Division 01 Section Quality Control an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company

of the International Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3 of this Section.

D. 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 as defined in OSHA Regulation 1910.7.

1.7. DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.

B. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path.

C. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

D. Store so condensation will not occur on or in panelboards. Provide temporary heaters as required to avoid condensation.

E. Handle panelboards according to NEMA PB 1.1. Use only factory-installed lifting provisions.

1.8. PROJECT CONDITIONS

A. Environmental Requirements: Do not install switchboards until space is enclosed and weatherproof, wet work space is completely and nominally dry, overhead work is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.

B. Verify Dimensions: Verify NEC and all Code clearance requirements by field measurements. Locate switchboard to meet installation tolerances.

C. Determine suitable path for moving switchboard into place considering Project conditions.

D. Revise locations and elevations from those indicated as required to suit Project conditions.

1.9. WARRANTY

A. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for the lesser of one (1) year from date of installation or eighteen (18) months from date of purchase.

1.10. EXTRA MATERIALS

A. Keys: Provide two (2) spares of each type of panelboard cabinet lock.

B. Touchup Paint: Provide one (1) standard size canisters of manufacturer's touch-up paint for every ten (10) panelboards, finish to match standard enclosure finish as specified herein. Furnish at least one (1) canister of touch-up paint.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, supply equipment from one of the following manufacturers; no other manufacturers are acceptable:

1. Square D Company. (Basis of Design)

2. Eaton Corp.; Cutler-Hammer Products.

3. Siemens Energy & Automation Inc.

4. General Electric (GE)

2.2. FABRICATION AND FEATURES

A. Enclosures: Provide steel enclosures, in compliance with NEMA PB1, suitable for flush- or surface-mounting as indicated on the Drawings. Type as indicated on the Drawings, unless otherwise indicated to meet environmental conditions at installed location as indicated below:

1. Dry, Interior Locations: NEMA 1

B. Enclosure Finish for Indoor Units: A minimum of one (1) coat of factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

C. Front: Secured to box with concealed trim clamps, unless otherwise indicated. Front for surface-mounted panelboards shall be same dimensions as box. Fronts for flush-mounted panelboards shall overlap box, unless otherwise indicated.

D. Buses and Connections: Three phase, four wire, unless otherwise indicated.

1. Bus Composition: Silver-plated or tin-plated copper, hard-drawn, minimum of 98 percent conductivity. Plating shall be applied continuously to bus work. The panelboard bussing shall be of sufficient cross-sectional area to meet UL 67 temperature rise requirements. The phase and neutral through-bus shall have an ampacity as shown on the Drawings. Coordinate bus short circuit rating with available fault current. Size in accordance with NEMA PB 1.

2. Phase and Neutral Buses: Provide mechanical lugs to accommodate the quantity, size, and material of the conductors shown on the Contract Drawings.

3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground

conductors. Bonded to box.

4. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity the entire length of the switchboard main and distribution sections. Provide for future extensions from both ends.

5. Neutral Buses: 100 percent of the ampacity of the phase buses, except as indicated, and equipped with approved pressure connectors for outgoing circuit neutral cables.

E. Future Devices: Equip with mounting brackets, supports, bus connections, and appurtenances for the overcurrent protective device ampere ratings indicated on the Drawings.

F. Directory Frame: Clear plastic cardholder, mounted inside each panelboard door.

G. Service Equipment Approval: Listed for use as service equipment for panelboards with main service disconnect.

H. Special Features: Include the following features for panelboards as indicated:

1. Subfeed: Over-current protective device or lug provision as indicated.

2. Feed-Through Lugs: Provide mechanical lugs to accommodate the quantity, size, and material of the conductors shown on the Contract Drawings.

3. Gutter Barrier: Arranged to isolate section of gutter as indicated.

2.3. OVERCURRENT PROTECTIVE DEVICES

A. Overcurrent protective devices include, but are not limited to, the following:

1. Electronic trip circuit breakers.

2. Thermal magnetic circuit breakers.

B. Molded-Case Circuit Breaker Features and Accessories:

1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.

2. Lugs: Mechanical style, suitable for quantity, size/gauge, and material of conductors indicated.

3. Application Listing: Appropriate for application, including switching lighting loads (Type SWD) or heating, air-conditioning, and refrigerating equipment (Type HACR).

4. Handle Padlock Attachment: Circuit breakers in panelboards shall be equipped with fixed handle padlock attachment to allow padlocking the circuit breaker in the ON or OFF position at the following locations:

a. Main circuit breakers in all panelboards.
b. Branch or sub-feed circuit breakers serving other panelboards.
c. Branch or sub-feed circuit breakers serving transformers.
d. Branch or sub-feed circuit breakers serving variable frequency drives and other equipment with integral disconnecting means where a separate disconnecting means is not provided under Division 26.
e. Other locations as indicated on the Contract Drawings.

5. Handle Clamp Attachment: Circuit breakers in panelboards shall be equipped with removable handle clamp attachments to prevent accidental operation of the circuit breaker at the following locations:

a. Branch circuit breakers serving emergency lighting and exit signs.
b. Branch circuit breakers serving fire alarm equipment.
c. Branch circuit breakers serving telecommunications equipment.
d. Branch circuit breakers serving refrigerators.
e. Other locations as indicated on the Contract Drawings.

6. Ground Fault Protection: Integral to circuit breaker with adjustable pickup and time delay settings, push-to-test feature, and ground-fault indicator.

7. Shunt Trip: 120 volt trip coil energized from separate circuit.

8. Auxiliary Contacts: Two SPDT switches with “a” and “b” contacts; “a” contacts shall mimic circuit breaker contacts, “b” contacts shall operate in reverse of circuit breaker contacts.

2.4. POWER DISTRIBUTION PANELBOARDS

A. Interior

1. Continuous main current ratings as indicated on Contract Drawings not to exceed 1200 amperes maximum. Panelboard bus current ratings shall be determined by heat-rise tests in accordance with UL 67.

2. Provide UL listed short-circuit current ratings (SCCR) as indicated on the Contract Drawings, not to exceed the lowest interrupting capacity rating of any circuit breaker installed with a maximum of 200,000 RMS symmetrical amperes. Main lug and main circuit breaker 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 interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.

4. The bussing shall be fully rated with sequentially phased branch distribution. Bus bar plating shall run the entire length of the bus bar. The entire interleaved assembly shall be contained between two (2) U-shaped steel channels, permanently secured to a galvanized steel mounting pan by fasteners.

5. Interior trim shall be of dead-front construction to shield user from all energized parts.

6. Main circuit breakers through 800 amperes shall be vertically mounted. Main circuit breaker and main lug interiors shall be field convertible for top or bottom incoming feed.

7. A solidly bonded equipment ground bar shall be provided.

8. Solid neutral shall be equipped with a full capacity bonding strap for service entrance applications. Gutter mounted neutral will not be acceptable.

B. Main Circuit Breakers – Electronic Trip Molded Case Type

1. Electronic trip, molded case, 80% rated circuit breaker with Micrologic® interchangeable ammeter trip unit with the following time/current response adjustments:

   a. Long Time Pickup
   b. Long Time Delay
   c. Short Time Pickup
   d. Short Time Delay
   e. Instantaneous Settings

2. Circuit breakers where the highest continuous current trip setting can be adjusted to 1200A or higher, shall be equipped with arc energy reducing maintenance setting, in compliance with National Electrical Code Article 240.87.

3. All adjustments shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.

4. Circuit breaker trip system shall be microprocessor-based true RMS sensing designed with sensing accuracy through the thirteenth (13th) harmonic.

5. Sensor ampere ratings shall be as indicated herein or on the Drawings.

6. Local visual trip indication for overload, short circuit and ground fault trip occurrences.

7. Long time pickup indication shall signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker.

8. Communications capabilities for remote monitoring of circuit breaker trip system, to include phase and ground fault currents, pre-trip alarm indication, switch settings, and trip history information shall be provided.

9. Provide phase loss/failure relay that will trip main circuit breaker on loss of any single phase. Main circuit breaker shall not trip during total power outage or loss of all three phases.

10. Basis of Design: Square D Company, Micrologic® Power Trip Units.

C. Group Mounted Circuit Breakers Through 1200A

1. Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.

2. Circuit breaker(s) equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breaker(s) shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breaker(s) of different frame sizes shall be capable of being mounted across from each other.

3. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.

4. Furnish thermal magnetic molded case circuit breakers for 250A frames and below.

D. Electronic Trip Molded Case Circuit Breakers

1. Electronic trip, molded case, 80% rated circuit breaker(s) with Micrologic® interchangeable ammeter trip unit and the following time/current response adjustments:

   a. Long Time Pickup
   b. Long Time Delay
   c. Short Time Pickup
   d. Short Time Delay
   e. Instantaneous Settings

2. Circuit breakers where the highest continuous current trip setting can be adjusted to 1200A or higher, shall be equipped with arc energy reducing maintenance settings, in compliance with National Electrical Code Article 240.87.

3. All adjustments shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.

4. Circuit breaker trip system shall be micro-processor based true RMS sensing designed with sensing accuracy through the thirteenth (13th) harmonic.

5. Sensor ampere trip ratings shall be as indicated on the Drawings.

6. Local visual trip indication for overload, short circuit [and ground fault] trip occurrences.

7. Long time pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.

E. Thermal Magnetic Molded Case Circuit Breakers

1. Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.

2. Ampere ratings shall be as shown on the Contract Drawings.

3. Ampere interrupting capacity ratings shall be as shown on the Contact Drawings, but not less than 18,000 AIC RMS symmetrical amperes at rated voltage.

F. Enclosures

1. Type 1 Enclosures

a. Boxes shall be hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements. Zinc-coated galvannealed steel will not be acceptable.
b. Boxes shall have removable blank end walls and interior mounting studs. Interior support bracket shall be provided for ease of interior installation.
c. Trim front steel shall meet strength and rigidity requirements per UL 50 standards. Shall have an ANSI 49 medium gray enamel electrodeposited over cleaned phosphatized steel.
d. Trim front door shall be 4-piece surface and shall have rounded corners and edges free of burrs.
e. Locks shall be cylindrical tumbler type with larger enclosures requiring sliding vault locks with 3-point latching. All lock assemblies shall be keyed alike.

G. Basis of Design – Square D Company, I-LINE Distribution Panelboards.

2.5. LIGHTING AND APPLIANCE PANELBOARDS

A. Interior

1. Minimum short-circuit current ratings shall be as indicated on the Contract Drawings, but not less than 10,000 AIC RMS symmetrical amperes for 120/208V panelboards, and 18,000 AIC RMS symmetrical amperes for 277/480V panelboards.

2. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors suitable for plug-on or bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat rise tests conducted in accordance with UL 67. Bus bar plating shall run the entire length of the bus bar.

3. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Article 230.

4. All current carrying parts shall be insulated from ground and phase to phase by high dielectric strength thermoplastic.

5. Interior trim shall be of dead front construction to shield user from energized parts. Dead front trim shall have preformed twist-outs covering unused mounting space.

6. Interiors shall be field convertible for top or bottom incoming feed.

7. Main circuit breakers over 100A shall be vertically mounted.

8. Sub-feed circuit breakers shall be vertically mounted.

9. Interior leveling provisions shall be provided for flush mounted applications.

10. Main lug interiors up to 400 amperes shall be field convertible to main breaker.

B. Main Circuit Breakers

1. Main circuit breakers shall have an over-center, trip free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and instantaneous magnetic trip elements in each pole. Each thermal element shall be true RMS sensing and be factory calibrated to operate in a 40 degrees C ambient environment. Thermal elements shall be ambient compensating above 40 degrees C.

2. Two and three pole circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker that allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push to trip button for maintenance and testing purposes.

3. Breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL listed for reverse connection without restrictive line or load markings.

C. Branch Circuit Breakers

1. Molded case branch circuit breakers shall have bolt-on type bus connectors.

2. Circuit breakers shall have an over-center toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and instantaneous magnetic trip elements in each pole. Two and three pole circuit breakers shall have common tripping of all poles.

3. There shall be two forms of visible trip indication. The breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red VISI TRIP indicator appearing in the clear window of the circuit breaker housing.

4. Circuit breakers serving transformers or other panelboards shall be equipped with factory-installed, fixed, handle padlock attachment to allow padlocking circuit breakers in the OFF only position.

D. Enclosures

1. Type 1 Enclosures

a. Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Galvannealed steel will not be acceptable.
b. Boxes shall have removable end-walls with knockouts located on one end.

Boxes shall have welded interior mounting studs.

c. Fronts shall meet strength and rigidity requirements per UL 50 standards. Front shall be finished with ANSI 49 gray baked enamel electrodeposited over cleaned phosphatized steel.

d. Panelboards shall have hinged front cover with entire front trim hinged to box with standard door within hinged front cover.

e. Front shall not be removable with the door locked.

f. Doors on front shall have rounded corners and edges shall be free of burrs.

g. A clear plastic directory card holder shall be mounted on the inside of the door.

h. All lock assemblies shall be keyed alike, one (1) key shall be provided with each lock.

E. Basis of Design – Square D Company, NQ/NF Series Panelboards.

2.6. SURGE PROTECTIVE DEVICES

A. Description: Integrated Surge Protective Devices (SPDs) in panelboards.

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

1. Square D Company - "IMA" Series

2. Eaton Corporation; Cutler-Hammer Products

3. Siemens Energy & Automation, Inc.

4. General Electric (GE)

C. The manufacturer of the SPD shall be the same as the manufacturer of the electrical distribution equipment in which the SPDs are installed and shipped.

D. Standards - Most recent editions of:

1. Underwriters Laboratories:

a. UL 1449 - "Surge Protective Devices"

b. UL 1283 - "Electromagnetic Interference Filters"

2. ANSI/IEEE C62.41.1-2002, C62.41.2-2002, C62.45-2002

3. National Electrical Code: Article 285 - "Surge Protective Devices, 1 kV or Less"

E. Listing Requirements:

1. SPD shall bear the UL Mark and shall be Listed to most recent editions of UL 1449 and UL 1283. "Manufactured in accordance with" is not equivalent to UL Listing and does not meet the intent of this Specification.

F. 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 2008 NEC

Article 285.6

G. SPD shall be UL labeled as Type 1, intended for use without need for external or supplemental overcurrent controls. Every suppression component of every mode, including Neutral-Ground (N-G), shall be protected by internal overcurrent and thermal over-temperature controls.

H. SPD shall be UL labeled with 20kA I-nominal (I-n) for compliance to UL 96A - "Installation Requirements for Lightning Protection Systems" for Master Label Certificate, and NFPA 780 - "Standard for the Installation of Lightning Protection Systems."

I. Minimum surge current capability (single pulse rated) per phase shall be as follows:

1. Distribution Panelboards: 240kA

2. Branch Panelboards: 120kA

J. SPD shall provide surge current paths for all modes of protection: Line-Neutral (L-N), Line-Ground (L-G), and Neutral-Ground (N-G) for Wye systems; Line-Line (L-L), and Line-Ground (L-G) in Delta and impedance grounded Wye systems.

K. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

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

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

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

M. SPD shall be constructed of one self-contained suppression module per phase.

N. Visible indication of proper SPD connection and operation shall be provided. SPD shall include LED indicator lights which shall indicate which phase as well as which module is fully operable.

O. The status of each SPD module shall be monitored on the front cover of the enclosure as well as on the module.

P. A push-to-test button shall be provided to test each phase indicator. Push-to-test button shall activate a state change of dry contacts for testing purposes.

Q. SPD shall be equipped with an audible alarm which shall activate when any one of the surge current modules has reached an end-of-life condition. An alarm on/off switch shall be provided to silence the alarm. The switches and alarm shall be located on the front

cover of the enclosure.

R. A connector shall be provided along with dry contacts (normally open or normally closed) to allow connection to a remote monitor or other system. The output of the dry contacts shall indicate an end-of-life condition for the complete SPD or module.

S. Terminals shall be provided for necessary power and ground connections.

T. A transient voltage surge counter shall be located on the diagnostic panel on the front cover of the enclosure. The counter shall be equipped with a manual reset and battery backup to retain memory loss upon loss of AC power.

U. SPD shall have a warranty period of ten (10) years from date of invoice and shall include unlimited replacement of suppression modules within the warranty period. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field service division.

2.7. IDENTIFICATION

A. Nameplates: Engraved nameplates shall be provided for all panelboards. Nameplates shall give item designation and circuit number as well as frame size and appropriate trip rating. Furnish Master Nameplate giving panelboard designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number.

B. Panelboards used as service-entrance equipment shall be labeled as the same.

C. Refer to Division 26 Section "Electrical Identification" for additional information.

PART 3. EXECUTION

3.1. EXAMINATION

A. Examine elements and surfaces to receive switchboard for compliance with installation tolerances and other conditions affecting performance of panelboards.

1. Do not proceed with installation until unsatisfactory conditions have been corrected.

2. Verify dimensions of panelboard and working space clearances.

3.2. INSTALLATION

A. Install panelboards and accessory items according to NEMA PB 1.1.

B. Mounting: Plumb and rigid without distortion of box**.** Mount flush panelboards uniformly flush with wall finish.

C. Panelboard dead fronts shall remain intact except where tabs are removed for circuit breakers. Install filler plates in unused pole spaces not filled by a circuit breaker that are accidentally opened. Do not remove all tabs in dead front and fill the same with filler plates.

D. Provision for Future Circuits at Flush-Mounted Panelboards: Stub 1-inch (25 mm) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future and/or 1-inch (25 mm) empty conduits into raised floor space or below slab not on grade, in accordance with the following schedule:

Total Number of Single Pole Spares and Spaces	Number of 1-inch Empty Conduits
1 – 3	Two
4 – 6	Three
7 – 9	Four
10 – 12	Five
13 – 20	Ten
21 – 32	Fifteen

E. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.

F. Two or three pole circuit breakers shall be common trip type. Single pole breakers with handle ties will not be permitted.

G. Tandem circuit breakers will not be permitted.

H. Multiple-section panelboards, as required by number of branch circuit breakers, shall consist of two or more cabinets with identical interiors mounted under separate trims. Cabinets, trims, and doors shall be 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 feed-through lugs and sub-feed cables installed within panel, equal to the incoming feeder size. All buses 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.

I. Provide ground buses in panelboards as indicated on the Drawings. Ground bus shall be similar in all respects to neutral bus.

J. Provide handle clamps for all branch circuit breakers or switches serving telephone and communications equipment, refrigerators, exit signs, fire alarm system controls, etc. to prevent accidental operation.

K. Branch circuit breakers serving electric water coolers shall be GFCI type for personnel protection (5mA).

L. Branch circuit breakers serving vending machines shall be GFCI type for personnel protection (5mA).

M. Height: Six-feet, six-inches to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above the floor. Top breaker maximum height not to exceed 6 feet 7 inches per NEC Article 404.8.

N. Do not energize or connect service-entrance equipment and panelboards to their sources until surge protective devices are properly installed and connected.

3.3. GROUNDING

A. Make equipment grounding connections for panelboards as indicated.

B. Provide ground continuity to main electrical ground bus as indicated.

3.4. CONNECTIONS

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

B. Neutral and ground conductors shall be isolated and terminated only at their respective bus bars. There shall only be one neutral-ground connection in service-entrance equipment by means of a removable main bonding jumper. Neutral and ground terminations at one bus bar shall not be acceptable.

3.5. IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section “Electrical Identification”.

B. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws. Refer to Division 26 Section “Electrical Identification” for nameplate requirements.

C. Panelboard Circuit Directories: Provide a typewritten directory, indicating plainly what each branch circuit of the panelboard serves and where. Provide additional information as required by NEC. Spaces and spare breakers shall be written in pencil. Copying of Contract Drawing Panel Schedules and Descriptions shall not be acceptable. Circuit directory shall reflect final circuit connections, loads and locations after balancing of panelboard loads.

3.6. FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection: Include the following inspections and related work:

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.

2. Clean devices using Manufacturer’s approved methods and materials.

3. Verify that panelboard nameplates are installed and accurate.

4. Verify that panelboard phase identification nameplates are installed.

5. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer’s instruction manual.

6. Check panelboard mounting, area clearances, and alignment and fit of components.

7. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.

8. Perform visual and mechanical inspection and related work for over-current protective devices.

9. Verify that all neutral conductors are bonded to the system ground at the service-entrance prior to installation of the surge protective device.

10. Verify that neutral-ground bonds do not exist at locations that are not service entrances or separately derived power sources.

B. Panelboard 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 "Conductors and Cables" for testing specific to feeder conductors.

6. Perform ground resistance test on system and equipment ground connections

7. Test main and subfeed over-current protective devices.

8. Infrared Scanning: Perform an infrared scan of all electrical connections in each panelboard, 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.

3.7. CLEANING

A. Upon completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.8. PROTECTION

A. Provide final protection and maintain conditions in a manner that shall ensure that the panelboard(s) shall be without damage at time of Substantial Completion.

END OF SECTION

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WIRING DEVICES
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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. Straight-blade receptacles.
2. GFCI receptacles.
3. Locking receptacles.
4. Weather-Resistant receptacles.
5. Toggle switches.
6. Wall-box occupancy sensor switches.
7. Device plates.
8. Cord and plug sets.
9. Emergency pushbuttons.

1.3. DEFINITIONS

A. GFCI: Ground-Fault Circuit Interrupter.

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

C. PIR: Passive Infrared.

D. RFI: Radio-Frequency Interference.

E. TR: Tamper-Resistant.

F. US: Ultra- Sonic.

G. WR: Weather-Resistant.

1.4. SUBMITTALS

A. Product Data: For each product specified, indicating configurations, finishes, dimensions,

and manufacturer's instructions.

B. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 01.

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.

B. Comply with NFPA 70.

C. Comply with NECA Standard of Installation.

D. Codes: Provide wiring devices conforming to the following:

1. American National Standards Institute (ANSI): Provide lugs and receptacle devices constructed in accordance with ANSI C73, Attachment Plugs and Receptacles, Dimensions of.

2. Institute of Electrical and Electronics Engineers (IEEE): Construct and install wiring devices in accordance with requirements of IEEE 241, Recommended Practice for Electric Power Systems in Commercial Building.

3. National Electrical Manufacturers Association (NEMA): Provide wiring devices constructed and configured in accordance with the requirements of

   a. WD1: General Requirements for Wiring Devices
   b. WD5: Special Purpose Wiring Devices
   c. WD6: Wiring Devices - Dimensional Requirements.
   d. WD7: Occupancy Motion Sensors Standard, 2011 Edition

4. National Fire Protection Association (NFPA): Comply with NFPA 70, National Electrical Code, as applicable to construction and installation of electrical wiring devices.

5. Underwriters Laboratories, Inc. (UL): Provide wiring devices which are UL listed and comply with the requirements of:

   a. 20: General-Use Snap Switches.
   b. 498: Attachments, Plugs and Receptacles
   c. 514A: Metallic Outlet Boxes.
   d. 514B: Fittings for Conduit and Outlet Boxes.
   e. 514C: Non-Metallic Outlet Boxes, Flush-Device Boxes, and Covers
   f. 943: Ground-Fault Circuit Interrupters

1.6. COORDINATION

A. Receptacles for Equipment Furnished with Cord and Plug Sets: Match plug configurations.

B. Cord and Plug Sets: Match equipment requirements.

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. Deliver extra materials to Owner.

1. Wallbox Occupancy Sensor Switches: One for each ten installed, but not less than one of each type.

PART 2. PRODUCTS

2.1. MANUFACTURERS

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

1. Wiring Devices:

a. Hubbell, Inc.; Wiring Devices Division
b. Pass & Seymour/Legrand; Wiring Devices Division
c. Leviton Manufacturing Co., Inc.
d. Eaton/Cooper; Wiring Devices Division
e. Lutron Electronics, Inc.

2. Wall-box Occupancy Sensor Switches:

a. Watt Stopper
b. Lutron Electronics, Inc.
c. Sensor Switch
d. Hubbell, Inc; Wiring Devices Division
e. Pass & Seymour/Legrand
f. Leviton Manufacturing Co, Inc.
g. Eaton/Cooper; Wiring Devices Division

3. Emergency Pushbuttons:

a. Safety Technology International, Inc. (STI)
b. Square D Company
c. Crouse-Hinds

2.2. STRAIGHT BLADE RECEPTACLES

A. General Requirements

1. Straight blade receptacles shall have the following basic features:

a. One-piece brass mounting strap with integral ground for low resistance of fault currents.
b. Auto-ground clip to assure positive ground.
c. Impact-resistant nylon face and thermoplastic base housing.

d. #10 large head brass terminal and ground screws; back- and side-wired.

B. Tamper-Resistant Duplex Convenience Receptacles

1. Tamper-resistant duplex convenience receptacles shall be extra heavy-duty, specification grade, 20A, 125V, with the following features:

   a. “TR” marking on face as required by UL standard.
   b. Thermoplastic dual mechanism shutter system to help prevent insertion of foreign objects.

2. Comply with NEMA WD-1, NEMA WD-6 configuration 5-20R, UL 498 and Federal Specification W-C-596.

3. Hubbell HBL5362TR, Pass & Seymour TR63, or approved equal by acceptable manufacturer.

C. Tamper-Resistant Isolated Ground Duplex Convenience Receptacles

1. Tamper-resistant isolated ground duplex convenience receptacles shall be extra heavy-duty, specification grade, 20A, 125V, with the following features:

   a. “TR” marking on face as required by UL standard.
   b. Thermoplastic dual mechanism shutter system to help prevent insertion of foreign objects.
   c. Green grounding screw connected directly to the grounding contacts.
   d. Insulation barrier construction to isolate ground contacts from the mounting strap.
   e. "IG" triangle on the face of the receptacle.

2. Comply with NEMA WD-1, NEMA WD-6 configuration 5-20R, UL 498 and Federal Specification W-C-596.

3. Hubbell IG5362TR, Pass & Seymour TRIG5362, or approved equal by acceptable manufacturer.

D. Weather-Resistant Duplex Convenience Receptacles

1. Weather-resistant duplex convenience receptacles shall be extra heavy-duty, specification grade, 20A, 125V, with the following features:

   a. "WR" marking on face as required by UL Standard.
   b. UV-resistant nylon face for longer life under adverse environmental conditions.

2. Comply with NEMA WD-1, NEMA WD-6 configuration 5-20R, UL 498, Federal Specification W-C-596 and 2011 NEC 406.9.

3. Hubbell HBL5362WR, Pass & Seymour WR5362, or approved equal by acceptable manufacturer.

E. Tamper-Resistant Duplex USB Charger Receptacles

1. Decorator style tamper-resistant duplex USB charger receptacles shall be heavy-duty, specification grade, 20A, 125V, with the following features:

    a. 5Vdc output, minimum 3.1 amperes
    b. Two (2) USB Type “A” ports,
    c. “TR” marking on face as required by UL standard.
    d. Thermoplastic dual mechanism shutter system to help prevent insertion of foreign objects.

2. Comply with NEMA WD-1, NEMA WD-6 configuration 5-20R, UL 498, UL1310, and Part 15 of FCC regulations.

3. Comply with battery charging specification USB BC1.2.

4. Compatible with USB 2.0/3.0 devices, including Apple® products.

5. Hubbell USB20A5, Pass & Seymour TR5362USB, or approved equal by acceptable manufacturer.

F. Tamper-Resistant Dual-Controlled Plug Load Controllable Duplex Receptacles

1. Dual-controlled plug load controllable tamper-resistant duplex convenience receptacles shall be extra heavy-duty, specification grade, 20A, 125V, with the following features:

    a. Permanent controlled receptacle marking on each receptacle face, in compliance with 2014 NEC Article 410.6(E), CA Title 24, and ASHRAE Energy Efficiency Standard 90.1.
    b. Thermoplastic dual mechanism shutter system to help prevent insertion of foreign objects.
    c. Green grounding screw connected directly to the grounding contacts.

2. Comply with NEMA WD-1, NEMA WD-6 configuration 5-20R, UL 498 and Federal Specification W-C-596.

3. Hubbell HBL5362C2TR, Pass & Seymour 5362CD Series, or approved equal by acceptable manufacturer.

G. Special Purpose Receptacles

1. Special purpose receptacles shall have ratings and NEMA configurations as indicated on the Drawings, or as required to match equipment plug configuration, and shall be black with device plate to match outlet type.

2.3. GFCI RECEPTACLES

A. General Requirements

1. GFCI receptacles shall have the following basic features:

    a. Solid-state ground-fault sensing and signaling.
    b. Trip time of 0.025 seconds (nominal).

c. Trip threshold of +/- 5mA.
d. Indicator light that is lighted when device is tripped.
e. Auto-ground clip to assure positive ground.
f. Impact-resistant nylon face and thermoplastic base housing.
g. #10 large head brass terminal and ground screws; back- and side-wired.

2. GFCI receptacles shall also have the following functions to comply with UL standard 943:

a. An auto-monitoring function that will allow for periodic automatic testing (self-test) of the GFCI device and its ability to respond to a ground fault. If a problem is detected one or more of the following will happen:
i. Power will be denied (trip with the inability to reset).
ii. Trip with the ability to reset, subject to the next auto-monitoring test cycle or repeatedly trip.
iii. Visual and/or audible indication
b. Provisions to ensure that receptacle type GFCIs that contain separate line and load terminals, and that is powered through its load terminals, shall not reset and supply power to its receptacle face or line terminals if miswired. This applies both during its initial installation and after reinstallation following a correctly wired installation. If the device is provided with special instructions for removal and reinstallation, the instructions shall be followed during testing.

B. Tamper-Resistant Duplex GFCI Receptacles

1. Tamper-resistant duplex GFCI receptacles shall be extra heavy-duty, specification grade, 20A, 125V with the following features:

a. “TR” marking on face as required by UL standard.
b. Thermoplastic dual mechanism shutter system to help prevent insertion of foreign objects.

2. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 and Federal Specification W-C-596.

3. Hubbell GFTRST20, Pass & Seymour 2097TR, or approved equal by acceptable manufacturer.

C. Weather-Resistant Duplex GFCI Receptacles

1. Weather-resistant duplex GFCI receptacles shall be extra heavy-duty, specification grade, 20A, 125V with the following features:

a. "WR" marking on face as required by UL Standard.
b. UV-resistant nylon face for longer life under adverse environmental conditions.

2. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 and Federal Specification W-C-596.

3. Hubbell GFWRST20, Pass & Seymour 2095/7TRWR, or approved equal by acceptable manufacturer.

2.4. LOCKING RECEPTACLES

A. Single Convenience Receptacles

1. Single convenience receptacles shall be extra heavy-duty, specification grade, 20A, 125V: Comply with NEMA WD1, NEMA WD6 configuration L5-20R, UL 498 and Federal Specification W-C-596.

B. Special Purpose Receptacles

1. Special purpose receptacles shall have ratings and NEMA configurations as indicated on the Drawings, or as required to match equipment plug configuration, and shall be black with device plate to match outlet type.

2.5. SWITCHES

A. General Requirements

1. Switches shall have the following basic features:

a. Heavy-gauge one-piece copper alloy contact arm.
b. Fast "make" and positive "break" to minimize arcing.
c. Heavy-duty bumper pads for quiet operation.
d. High strength thermoplastic polycarbonate toggle.
e. Oversized silvery alloy contacts for long life and heat dissipation.
f. Nickel-plated steel strap with integral ground.
g. Auto-ground clip to assure positive ground.

B. Toggle Switches

1. Toggle switches shall be quiet-type, extra heavy-duty, horsepower-rated, industrial grade, 120/277V, 20A: Comply with NEMA WD 1, UL 20 and Federal Specification W-S-896.

2. Hubbell HBL1221 (single-pole), HBL1222 (two-pole), HBL1223 (three-way), HBL1224 (four-way), Pass & Seymour PS20AC1 (single-pole), PS20AC2 (two-pole), PS20AC3 (three-way), PS20AC4 (four-way), or approved equal by acceptable manufacturer.

C. Decorator Switches

1. Decorator switches shall be quiet-type, heavy-duty, specification grade, 120/277V, 20A, with cushioned thermoplastic paddle.

2. Comply with NEMA WD 1, UL 20 and Federal Specification W-S-896.

3. Hubbell DS120 (single-pole), DS220 (two-pole), DS320 (three-way), DS420 (four-way), Pass & Seymour 2621 (single-pole), 2622 (two-pole), 2623 (three-way), 2624 (four-way), or approved equal by acceptable manufacturer.

D. Illuminated Toggle Switches (Light On with Load Off)

1. Illuminated toggle switches shall be quiet-type, extra heavy-duty, horsepower-rated, industrial grade, 120/277V, 20A, with clear illuminated toggle, lighted with load off.

2. Comply with NEMA WD 1, UL 20 and Federal Specification W-S-896.

3. Hubbell HBL1221ILC (single-pole), HBL1223ILC (three-way), Pass & Seymour PS20AC1-CSL (single-pole), PS20AC3-CSL (three-way), or approved equal by acceptable manufacturer.

E. Pilot Lighted Switches (Light On with Load On)

1. Pilot lighted switches shall be quiet-type, extra heavy-duty, horsepower-rated, industrial grade, 120/277V, 20A, with red illuminated toggle, lighted with load on.

2. Comply with NEMA WD 1, UL 20 and Federal Specification W-S-896.

3. Hubbell HBL1221PL (single-pole), HBL1222PL (two-pole), HBL1223PL (three-way), Pass & Seymour PS20AC1RPL (single-pole), PS20AC2RPL (two-pole), PS20AC3RPL (three-way), or approved equal by acceptable manufacturer.

F. Lockable Switch Handle Guards

1. Provide handle guards with provisions for padlocking at all toggle switches serving as disconnecting means and where indicated on the Drawings.

2. Handle guards shall be steel construction, and shall mount directly over standard switch faceplates.

3. Provide Square D Class 2510 FL1, or approved equal by listed manufacturer.

2.6. WALL-BOX OCCUPANCY SENSOR SWITCHES

A. Wall switch sensors shall be capable of detection of motion at desk-top level up to 300 square feet, and gross motion up to 1,000 square feet.

B. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1200 watts at 277 volts and shall have 180 degree coverage capability.

C. Sensors shall be dual technology type using a combination of passive-infrared and ultrasonic detection method to distinguish between occupied and unoccupied conditions for area covered.

D. Sensors shall feature built-in light level sensing for field-adjustable ambient light override.

E. All sensors shall be capable of operating normally with any electronic ballast and PL lamp systems.

F. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioning or heating

fans.

G. All sensors shall have readily accessible, user adjustable controls for time delay and sensitivity. Controls shall be recessed to limit tampering.

H. Ultrasonic operating frequency shall be crystal controlled to within plus or minus 0.005 percent tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.

I. All sensors shall provide a method of indication to verify that motion is being detected during testing and that the unit is working.

J. All sensors shall have no leakage current to load, in manual or in Auto/Off Mode, for safety purposes and shall have voltage drop protection.

K. All sensors shall have UL rated, 94V-0 plastic enclosures.

L. Sensor finishes shall match finish of toggle switches as specified herein.

2.7. FINISHES

A. Wiring device catalog numbers in Section text do not designate device color. Device colors shall be as follows, unless otherwise indicated elsewhere in the Specifications and Drawings or as required by NFPA or device listing:

1. Wiring Devices connected to Normal Power System: White.

2. Wiring Devices connected to Emergency Power System: Red

3. Special Receptacles: Black.

2.8. DEVICE PLATES

A. Device plates shall be provided for all switches and receptacles. Device plates shall be as manufactured to fit each type of single device, to fit devices which are ganged together, and they shall be same manufacturer as wiring devices with finish as follows:

1. Material for Unfinished Spaces: Galvanized steel, unless otherwise noted.

2. Material for Finished Spaces: 0.04-inch-thick, Type 302, satin-finished stainless steel, except as otherwise indicated.

3. Plate-Securing Screws: Metal with heads colored to match plate finish.

B. Covers for Receptacles and Switches in Damp Locations: Heavy-duty die-cast zinc/aluminum construction with gasketed, hinged lid, listed and labeled for use in “damp locations.” All components shall have baked-on electrostatic, polyester, power paint finish for superior corrosion resistance. Covers 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 receptacles shall comply with NEC Article 406.9(A). Covers for switches shall comply with NEC Article 404.4.

1. Horizontal Receptacles - Pass & Seymour Model No. CA26H or approved equal by Hubbell, Intermatic or other listed manufacturer.

2. Vertical Receptacles – Pass &Seymour Model No. CA26V, or approved equal by Hubbell, Intermatic, or other listed manufacturer.

3. Toggle Switches – Pass and Seymour Model No. CA1, or approved equal.

C. Covers for Receptacles in Damp and Wet Locations: Heavy-duty die-cast zinc/aluminum construction with hinged lockable lid, designed to be weatherproof while the device is in use, and listed and labeled "extra duty" for use in "wet locations". All components shall have baked-on electrostatic, polyester, power paint finish for superior corrosion resistance. Covers shall comply with NEC Article 406.9(B).

1. Duplex/GFCI Receptacles – Pass & Seymour Model No. WIUCAST1 or approved equal by Hubble, Intermatic, or other listed manufacturer.

D. Covers for Switches in Damp and Wet Locations: Heavy-duty die-cast zinc/aluminum construction with actuating levers and shall mount directly over the switch. Covers shall comply with NEC Article 404.4 and shall be UL listed for use in wet locations.

1. Toggle Switches – Crouse –Hinds Model No. DS185, or approved equal.

2.9. EMERGENCY PUSHBUTTONS

A. General:

1. Emergency pushbuttons shall be Stopper Station with Mini 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. Pushbuttons shall include one N.O. and one N.C. contact, unless otherwise indicated on the Contract Drawings.

4. Pushbuttons 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. "Water Heater Shut-Down"
b. "Boiler Shut-Down"

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. 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.

PART 3. EXECUTION

3.1. EXAMINATION

A. Verification of existing conditions before starting work.

B. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.

1. Verify that outlet boxes are installed at proper height.

2. Verify that wall openings are neatly cut and will be completely covered by wall plates.

3. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

C. By beginning Work, accepts conditions and assume responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.2. INSTALLATION – GENERAL

A. Install devices and assemblies plumb, level, and secure.

B. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top or as required by the local Authority Having Jurisdiction. Exception: Mount exterior GFCI weatherproof duplex receptacles horizontally with grounding terminals on the left, or as required by the local Authority Having Jurisdiction. Group adjacent switches under single, multi-gang wall plates.

C. Install wall plates when painting is complete.

D. Protect devices and assemblies during painting.

E. Coordinate cord and plug connected equipment for type and ratings required.

F. Switch and receptacle combinations shall be installed in a 2-gang box where both are of the same voltage. Provide separate boxes where different voltages are present.

3.3. INSTALLATION – RECEPTACLES

A. All 15 ampere and 20 ampere, 125 volt and 250 volt, non-locking type receptacles installed in damp or wet locations shall be listed weather-resistant type in accordance with NEC Article 406.9(A) and 406.9(B) and shall be installed within an enclosure that is weather proof when an attachment plug is inserted.

B. All 15 ampere and 20 ampere, 125 volt, single-phase, non-locking type receptacles installed in the following locations shall have GFCI protection for personnel, in accordance with NEC Article 210.8(B).

1. Bathrooms/Toilet Rooms

2. Rooftops

3. Outdoors

4. Within six (6) feet (1.8m) of sinks, plumbing fixtures and water piping.

5. Indoor wet locations.

6. Mechanical rooms, electrical rooms, and similar areas where electrical hand tools or portable lighting equipment are to be used.

C. Where multiple receptacles are indicated on the Contract Drawings as GFCI type receptacles, each device must be a GFCI type receptacle. Protecting standard receptacles downstream from one GFCI receptacle is not acceptable**.**

3.4. INSTALLATION – SWITCHES

A. Emergency shut-down push-buttons for gas-fired equipment shall be provided at all means of egress from rooms in which gas-fired equipment is installed.

B. Switches shall be located as indicated on the drawings, arranged singular or in gangs within 18" of the door jamb on the strike side of the door openings. Verify the door swings with the Architectural Drawings prior to rough-in.

3.5. INSTALLATION – OCCUPANCY SENSORS

A. Locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations.

B. The following areas shall have one hundred (100%) percent coverage for minor (small resolution) motion:

1. Teacher's desks

2. Desks in office areas

C. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. Provide, at the Owner's facility, the training necessary to familiarize the Owner's personnel with the operation, use, adjustment, and problem-solving diagnosis of the occupancy-sensing devices and systems.

1. Sensors installed in damp locations such as near showers, in wet locations, or where exposed to rain shall be equipped with watertight/weatherproof enclosure.

2. Mounting of passive infrared and dual technology sensors where columns, doors, walls, or other obstructions will block the sensor's field of view should be avoided.

3. Passive infrared coverage should not extend through doorways. Masking inserts shall be installed for PIR coverage rejection to prevent false tripping.

D. Install system components in accordance with Manufacturer's instructions. Sensor locations are approximate and are designed according to the specified manufacturer.

E. Sensors shall be positioned so that lights are activated when a person is 2 feet or less through any doorway.

F. Prior to energizing circuits, wiring shall be tested for electrical continuity and short circuits to ensure proper polarity of connections is maintained.

3.6. IDENTIFICATION

A. Comply with Division 26 Section "Electrical Identification".

1. Switches: Switches shall be labeled as to lights/load controlled and with circuit number and panel identification.

2. Receptacles: All device plates shall be labeled to 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. Labels shall be clear with black lettering. Protect label from damage during construction. Replace all damaged and unclear labels.

3. Pre-wired workstations are also required to have each receptacle labeled to identify the panelboard and circuit number from which it is served.

4. Mark all conductors with the panel and circuit number serving the device at the device.

5. 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.

6. Faceplate labels shall be installed such that they are readable and do not cover any portion of the faceplate securing screw(s) or the wiring device itself.

3.7. CONNECTIONS

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

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

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

3.8. FIELD QUALITY CONTROL

A. Test wiring devices for proper polarity, continuity, short circuits, and ground continuity. Operate each device at least six times.

B. Replace damaged or defective components.

3.9. CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION

DIVISION 26 SECTION 262813
FUSES
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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 Cabinets.

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. Record the equipment nameplate rating and actual fuse rating and location of fuses on the record drawings.

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 smaller fuse type and size installed, but not less than one (1) set of three (3) of each type and size.

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. General Electric Co; Wiring Devices Div.

4. Mersen (formerly Ferraz Shawmut)

5. 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.

B. Fuses shall feature a solid state visual open fuse indicator, metal-embossed date and catalog number for identification.

2.3. SPARE FUSE CABINETS

A. Description: Wall-mounted, locking utility cabinet(s) with shelves for spare fuses.

B. Construction: 16 or 14 gauge steel, ANSI 61 gray polyester powder paint finish inside and out.

C. Features:

1. Four mounting keyholes in back of enclosure

2. Removable door with reversible hinge; door can hinge from either left or right side and can be changed without tools

3. Door has quarter-turn key lock; two keys included

4. Retractable spring hinge

5. Three solid shelves.

D. Dimensions: Cabinet shall be of proper size for orderly storage of spare fuses and fuse pullers stored in the same, plus space for 15 percent spare capacity.

E. Fuse Pullers: Provide one (1) fuse puller for each size and type fuse stored in each spare fuse cabinet.

F. Basis of Design: Provide shelf style locking utility cabinets as manufactured by Hoffman/Pentair, or approved equal by Cooper/Bussman.

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 Feeders: Class J, time delay, 600Volt, 0-600 Amp, and 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.

B. 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.

1. The following guidelines apply for motors protected by properly sized overload relays:

   a. 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.
   b. 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.

2. The following guidelines apply where fuses are used as the only overload protection for the motor:

   a. 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).
   b. 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.

3. Fuse sizes for motor protection shall be chosen from fuse manufacturers published data and recommendations.

C. Other Branch Circuits: Class RK1, non time delay, 250 Volt, Class J Time Delay 600 Volt, 0-600 Amp, and 300 kA interrupting rating.

D. Control Circuits: Class CC, current limiting rejection type, rated 0-30 amperes, 600 volts, and 200- kA interrupting rating.

E. Provide fuses of type and rating recommended by equipment manufacturer for packaged and/or specialized equipment.

F. Six hundred ampere or less, installed ahead of breaker: Class RK1, time delay.

G. 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.

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.

B. Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings and open fuse indicator are visible without removing fuse.

C. Installation: Provide one (1) locking fuse cabinet in each new mechanical room. Cabinet(s) shall be mounted 5’-6” to top unless otherwise noted on the Contract Drawings.

D. Provide fuse clips as required.

3.4. IDENTIFICATION

A. Identification: Provide engraved nameplate to read “SPARE FUSES” in 1/2" high lettering on front door of cabinet(s). Refer to Division 26 Section, “Electrical Identification” for nameplate requirements.

END OF SECTION

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DISCONNECT SWITCHES & CIRCUIT BREAKERS
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DISCONNECT SWITCHES & CIRCUIT BREAKERS

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 individually mounted disconnect switches and circuit breakers used for the following:

1. Equipment disconnect switches.

2. Feeder disconnect switches.

3. Motor disconnect switches.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 26 Section, “Wiring Devices” for toggle switches used as disconnecting means.

2. Division 26 Section, “Fuses” for fuses in fusible disconnect switches.

C. Provide method of disconnection at all appliances, motors, equipment, etc., as required to comply with NEC (including Article 422-C, and Article 440-D).

1.3. ALTERNATES

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

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 disconnect switches, circuit breakers, and accessories specified in this Section. Include the following:

1. Descriptive data and time current curves.

C. Submit a schedule of equipment to indicate ratings of disconnects, fuses, circuit breakers, and other electrical characteristics for each item of equipment.

D. Maintenance data for disconnect switches and circuit breakers to include in the operation and maintenance manual specified in Division 01.

1.5. QUALITY ASSURANCE

A. Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.

B. Comply with NFPA 70 for components and installation.

C. Listing and Labeling: Provide disconnect switches and circuit breakers 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. Underwriters Laboratories (UL) listed equipment: UL 98 - Enclosed and Dead Front Switches, UL 50 - Cabinets and Boxes, UL489 - Molded Case Circuit Breakers and Circuit Breaker Enclosures, NEMA 250 - Enclosures for Electrical Equipment.

4. Comply with ANSI and NEMA Standards for materials ratings.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide equipment from one of the following manufacturers; no other manufacturers are acceptable.

1. Disconnect/Safety Switches:

a. Square D Company. (Basis of Design)
b. Eaton Corp.; Cutler Hammer.
c. Siemens Energy & Automation, Inc.
d. General Electric (GE)

2. Enclosed Circuit Breakers:

a. Square D Company. (Basis of Design)
b. Eaton Corporation; Cutler Hammer.
c. Siemens Energy & Automation, Inc.
d. General Electric (GE)

2.2. DISCONNECT SWITCHES

A. Enclosed, Nonfusible Switch: Heavy duty, NEMA KS 1, Type HD, with lockable handle in the OFF position. Switch shall be provided with an override screw to permit opening front cover with switch in ON position. Minimum fault current rating shall be 200,000 symmetrical rms amperes.

B. Enclosed, Fusible Switch, 800 A and Smaller: Heavy duty, NEMA KS 1, Type HD, clips

to accommodate specified fuses, enclosure consistent with environment where located, handle lockable in the OFF position, with 2 padlocks, and interlocked with cover in CLOSED position. Switch shall be provided with an override screw to permit opening front cover with switch in ON position. Minimum fault current rating shall be 200,000 symmetrical rms amperes.

C. Characteristics: Size, number of poles and ratings as indicated and to match load being served.

D. Enclosure: NEMA KS 1, Type 1, with gray baked enamel finish, unless otherwise specified or required to meet environmental conditions of installed location. Enclosure shall be rated for 200,000 rms symmetrical amperes short circuit current.

1. Outdoor Locations: Type 3R, with top-hinged, attached with removable screws.

2.3. ENCLOSED CIRCUIT BREAKERS

A. Enclosed, Molded Case Circuit Breakers: NEMA AB 1, with lockable handle.

B. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting rating to meet available fault current, minimum of 10,000 symmetrical rms amperes.

C. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air conditioning, and refrigerating equipment.

D. Circuit Breakers, 250 Ampere Frame and Smaller: Factory sealed thermal magnetic trip units.

E. Circuit Breakers, 400 Ampere Frame and Larger: Electronic trip units with field adjustable, short time and continuous current settings.

F. Molded Case Switch: Where indicated, molded case circuit breaker without trip units.

G. Lugs: Mechanical lugs and power distribution connectors for number, size, and material of conductors indicated.

H. Shunt Trip: Where indicated. Provide voltage rating as required.

I. Accessories: As indicated.

J. Enclosure: NEMA AB 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.

K. Provide full capacity neutral lug and equipment grounding lug as required.

PART 3. EXECUTION

3.1. INSTALLATION

A. Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.

B. Install disconnect switches and circuit breakers level and plumb. Provide mounting brackets, wall bracing, and accessories as required.

C. Install disconnect switches and circuit breakers to have adequate working space in accordance with Article 110.26 of the National Electrical Code. Disconnect switches and circuit breakers shall not be installed beneath ductwork, piping, etc.

D. Install wiring between disconnect switches, circuit breakers, and associated control and indication devices.

E. Provide fuses for all fusible safety switches as indicated and required by the load being served. Coordinate fuse ratings with mechanical equipment electrical characteristics.

F. Provide disconnect switches for all equipment as indicated and as required by the NEC. Where disconnect switches are specified and furnished with mechanical equipment, install one only. Coordinate devices furnished for mechanical equipment with Division 23 Drawings and Specifications.

G. Weatherproof enclosures shall be provided for all disconnect switches and circuit breakers exposed to the elements whether called for or not.

H. Disconnect Switches and circuit breakers provided shall be suitable for:

1. Circuit application voltage.

2. Circuit application ampacity x 125 percent.

3. One pole, two pole, three pole, solid neutral, ground connection, all as required by item served or as shown on the drawings.

I. Install disconnect switches and circuit breakers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's Standard of Installation, and in accordance with recognized industry practices.

3.2. CONNECTIONS

A. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer.

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

3.3. IDENTIFICATION

A. Identify each disconnect switch and circuit breaker according to requirements specified in Division 26 Section, "Electrical Identification". All switches shall be provided with engraved nameplates which clearly identify the equipment served, circuit designation, and circuit voltage/phase.

B. Each disconnect means shall be legibly marked as required by Code (including integral disconnect units furnished with motors, appliances, feeders, and branch(es).

3.4. FIELD QUALITY CONTROL

A. Visual and mechanical inspection: Include the following inspections and related work.

1. Device Ratings and Settings: Verify that ratings and settings as installed are appropriate for final loads and final system arrangement and parameters. Recommend final protective-device ratings and settings where differences are found. Use accepted revised ratings or settings to make the final system adjustments. Prepare and submit the load current and overload relay heater list.

2. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current project drawings.

3. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instructions.

4. Check tightness of electrical connections of devices with calibrated torque wrench. Use Manufacturer's recommended torque values.

5. Clean devices using Manufacturer's approved methods and materials.

6. Verify proper fuse types and ratings in fusible devices.

7. Verify that fuses are facing out and that fuse ratings and blown fuse indicators are visible without removing fuses.

3.5. ADJUSTING

A. Adjust/replace fuses in disconnect switches if required to properly coordinate with overcurrent protection requirements of equipment served and with upstream and downstream protective devices.

3.6. CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION

DIVISION 26 SECTION 262913
MOTOR CONTROLLERS
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MOTOR CONTROLLERS

PART 1. GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SUMMARY

A. This Section includes AC motor-control devices rated 600 V and less that are supplied as enclosed units.

B. Related Sections include the following:

1. Division 26 Section "Common Work Results for Electrical" for Mechanical - Electrical coordination requirements.

2. Division 26 Section "Common Work Results for Electrical" for general materials and installation methods.

3. Division 26 Section "Electrical Identification" for labeling materials.

4. Division 26 Section "Fuses" for fuses installed in combination magnetic motor controllers with fusible disconnect switches.

1.3. ALTERNATES

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

1.4. DEFINITIONS

A. N.C.: Normally closed.

B. N.O.: Normally open.

C. OCPD: Overcurrent protective device.

1.5. SUBMITTALS

A. Product Data: For products specified in this Section. Include dimensions, ratings, and data on features and components.

B. Maintenance Data: For products to include in the operation and maintenance manuals specified in Division 01.

C. Submit a schedule of equipment to indicate motor controller ratings, sizes, and other electrical characteristics for each item of equipment.

1.6. QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain, within 50 miles (80 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain similar motor-control devices through one source from a single manufacturer.

C. Comply with NFPA 70.

D. Listing and Labeling: Provide motor controllers 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 as defined in OSHA Regulation 1910.7.

E. UL Compliance: NEMA ICS 2, Industrial Control Devices, Controllers and Assemblies.

1.7. 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 temporary electric heating, with at least 250 W per controller.

1.8. 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).

1.9. COORDINATION

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

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

C. The horsepower rating of all starters shall be checked against actual motor to be controlled,

before installation and correct size overload elements shall be provided in all starters based on nameplate and manufacturer's recommendation.

D. Provide all control devices and wiring, where not provided under Division 23, required for all equipment.

E. Motors and controllers shall be provided for voltage and current characteristics as indicated. In the event that equipment provided is of different electrical characteristics than the ones specified, any increase in electrical feeders, conduits, circuit breakers, etc., including increase of labor cost shall be the responsibility of the Contractor.

F. Provide branch circuits for all motors to the starting equipment and then to the motors, complete with all control wiring for automatic and remote control where required or noted. Conduits to motors shall terminate in the conduit fittings on the motors, the final connection being made with flexible metal conduit (FMC) in dry locations and with Liquid-Tight Flexible Metal Conduit (LFMC) in damp/wet locations.

G. All conduits and wiring required for control work from the holding coil circuit of the starter, including the furnishing and installation of control devices such as auxiliary contacts, control relays, time delay relays, pilot lights, selector switches, alternators, etc., shall be provided and installed by other trades unless otherwise indicated.

H. Power Branch Circuits: Wire sizes for branch circuits not specifically called for on drawings or in Specifications shall be based on 125 percent of the full load current of the motor unless the voltage drop of motor branch circuits exceeds 1-1/2 percent from the distribution panel to the motor; in which case, voltage drop shall govern wire sizes. A power factor of 80 percent shall be used for motors in such calculations.

1.10. 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. Overload Relays: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

2. Pilot Lights: Equal to 10 percent of quantity installed for each type, but no fewer than two of each type. Where lamps are field replaceable, furnish spare lamps only.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, supply equipment from one of the following manufacturers. No other manufacturers are acceptable.

1. Square D Company; Groupe Schneider. (Basis of Design).

2. Eaton Corporation; Westinghouse & Cutler-Hammer Products.

3. Siemens Energy and Automation, Inc.

4. Allen-Bradley Company; Industrial Control Group.

5. Crouse-Hinds ECM; Cooper Industries, Inc. Division.

6. General Electric (GE).

B. All motor controllers shall be NEMA type controllers. IEC type controllers shall NOT be acceptable.

2.2. MANUAL MOTOR CONTROLLERS

A. Description: NEMA ICS 2, AC general-purpose Class A manually-operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit. Manual motor controllers shall be equipped with red pilot light, hand-off-automatic selector switch and toggle operator. Provide size and number of poles as required for a complete installation of the equipment being connected. Coordinate voltage of pilot light with voltage/phase of circuit serving equipment.

B. Thermal Overload Units:

1. Thermal overload units shall be melting alloy type, properly sized for the equipment being protected, and shall be interchangeable. Controller shall be inoperable if thermal overload unit is removed.

C. Enclosure: ANSI/NEMA ICS 6; Type 1 for interior use and Type 4 water-tight and dust tight die-cast zinc for damp/wet locations. Provide flush-mounted enclosures for units located in finished areas. Provide handle guard with locking provisions in the "off" position on all enclosures.

D. Furnish Square D, Class 2510 Type F motor controllers with 2510 FL1 handle guard, or approved equal.

2.3. MANUAL MOTOR SWITCHES

A. Description: NEMA ICS 2, AC general-purpose Class A manually-operated, full-voltage controller for integral horsepower induction motors, without thermal overload unit. Manual motor switches shall be equipped with red pilot light and toggle operator. Provide size and number of poles as required for a complete installation of the equipment being connected. Coordinate voltage of pilot light with voltage/phase of circuit serving equipment.

B. Enclosure: ANSI/NEMA ICS 6; Type 1 for interior use and Type 4 water-tight and dust tight die-cast zinc for damp/wet locations. Provide flush-mounted enclosures for units located in finished areas. Provide handle guard with locking provisions in the "off" position on all enclosures.

C. Furnish Square D, Class 2510 Type K motor controllers with 2510 FL1 handle guard, or approved equal.

2.4. MOTOR DISCONNECT SWITCHES

A. Description: Manually operated, full voltage, UL508 horsepower rated, enclosed motor disconnect switch, 60 ampere, 3 pole, 600 volt rating without thermal overload unit. Motor Disconnect Switch shall be equipped with a handle interlock to prevent the cover from being removed while in the “on” position.

B. Enclosure: Water-tight, NEMA 4X, polycarbonate enclosure, surface mounting, for either interior or exterior locations. Cover shall have a clear “on/off” indication with a front padlockable handle which complies with OSHA lockout/tagout requirements.

C. Furnish Square D, Class 3100, Type MD Motor Disconnect Switch or approved equal.

PART 3. EXECUTION

3.1. APPLICATIONS

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

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

C. Use fractional-horsepower manual motor controllers for single-phase motors, unless otherwise indicated.

D. Hand-Off-Automatic Selector Switches: In covers of motor controllers started and stopped by automatic controls or interlocked with other equipment.

E. Provide heaters and/or fuses correlated with full load nameplate current of motors provided. Set adjustable overload devices to suit motor provided.

3.2. INSTALLATION

A. Install motor controllers in locations as indicated, according to manufacturer's written instructions.

B. Install motor controllers level and plumb. Provide mounting brackets, wall bracing, and accessories as required.

C. Install motor controllers to have adequate working space in accordance with Article 110.26 of the National Electrical Code. Motor controllers shall not be installed beneath ductwork, piping, etc.

D. Install independently mounted motor-control devices according to manufacturer's written instructions.

E. Location: Locate controllers within sight of motors controlled, unless otherwise indicated.

F. 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 conforming to Division 26 Section “Hangers and Supports”.

3.3. IDENTIFICATION

A. Identify motor-control components and control wiring according to requirements specified in Division 26 Section “Electrical Identification”.

B. All motor controllers shall be provided with engraved nameplates which clearly identify the equipment served, circuit designation, and circuit voltage/phase.

3.4. CONTROL WIRING INSTALLATION

A. Install wiring between motor-control devices according to Division 26 Section “Conductors and Cables”.

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

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

3.5. CONNECTIONS

A. Connect motor controllers and components to wiring system and to ground as indicated and instructed by manufacturer.

B. Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6. FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection: Include the following inspections and related work.

1. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with drawings and schedules.

2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer’s instructions.

3. Check tightness of electrical connections of devices with calibrated torque wrench. Use Manufacturer’s recommended torque values.

4. Clean devices using Manufacturer’s approved methods and materials.

5. Verify proper fuse types and ratings in fusible devices.

6. Verify that fuses are facing out and that fuse ratings are readable without removing fuses.

7. Verify proper thermal overload types and ratings in devices with thermal overload protection.

8. Verify proper operation of pilot lights.

9. Verify proper operation of hand-off-automatic selector switches.

10. Motor-Control Device Ratings and Settings: Verify that ratings and settings as installed are appropriate for final loads and final system arrangement and parameters. Recommend final protective-device ratings and settings where differences are found. Use accepted revised ratings or settings to make the final system adjustments. Prepare and submit the load current and overload relay heater list.

3.7. CLEANING

A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

END OF SECTION

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LIGHTNING PROTECTION SYSTEM
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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.

B. Refer to Division 26, Section "Common Work Results for Electrical", for basic electrical installation requirements.

C. Refer to Division 26, Section "Panelboards", for Surge Protective Device (SPD) requirements.

1.2. SUMMARY

A. This section includes lightning protection systems for buildings and associated structures and includes requirements for lightning protection system components complying with UL96, UL96A, and NFPA 780.

B. Contractor shall provide additional components and labor in order to meet all requirements of a UL Master Labeled Lightning Protection System.

1.3. SYSTEM DESCRIPTION

A. Protect entire addition, including roof projections, canopies, and roof-mounted equipment.

1. Building Construction: Steel building less than 75 feet (23m) in height.

2. Building Occupancy: Commercial.

B. New lighting protection system shall be connected to the existing lighting protection system protecting the existing school.

C. Provide a complete UL Master Labeled Lightning Protection System.

D. Provide a complete all-inclusive Lightning Protection System Design layout and installation for a complete UL Master Labeled Lightning Protection System.

E. Design Requirements: Lightning Protection Conductor System consisting of air terminals on roofs, roof-mounted mechanical equipment, parapets, bonding of structure and other metal objects, grounding electrodes, and interconnecting conductors.

F. Provide an all-inclusive Lightning Protection System. The Contract Drawings and Specifications do not necessarily limit the extent of the system that is required to meet the requirements and the intent of the Engineer and the Contract Documents for a complete system.

1.4. SUBMITTALS

A. General: Submit the following according to Conditions of Contract and Division 01 Specification Sections.

B. Product data for each component: Include data for roof adhesive when used. Submit accurate pictorial views of decorative air terminal components. Provide dimensions and materials of each components and include indication of listing in accordance with UL 96.

C. Provide scaled shop drawings detailing lightning protection system including, but not limited to, air terminal locations, grounding electrodes, conductor sizes and routing, bonding connections to structures, and connections and grounding. Include connection and termination details. The shop drawings shall be Master Labeled stamped. Submit a roof plan and a ground floor plan with all equipment properly dimensioned.

D. 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 Architects and Owners, and other information specified.

E. Field inspection reports indicating compliance with specified requirements.

F. Project Record Documents - Accurately record the following: Actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors in project record documents.

G. Submit a UL compliance certificate indicating compliance with all requirements.

1.5. QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced and LPI-Certified Master Installer to install the Lightning Protection System. The installation shall be under the direct supervision of an LPI-Certified Master Installer.

B. Designer Qualifications: Engage an LPI-Certified Designer to design and lay out the Lightning Protection System.

C. Inspector Qualifications: Engage an LPI-Certified Inspector to perform periodic inspections during installation of the Lightning Protection System.

D. Manufacturers Qualifications: Provide products by firms listed and approved by Underwriters Laboratories, Inc., having had not less than five (5) years experience in this specialty work under UL procedures.

E. Listing and Labeling: Provide products specified in this Section that are listed and labeled by an organization concerned with product evaluations, and that can determine compliance with appropriate standards for he current production of listed items.

1. Listing and Labeling Agency Qualifications; A Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

F. Conform to NFPA 780, Lightning Protection Code.

G. Conform to UL 96, Standard for Lightning Protection Components.

H. Conform to UL 96A, Installation Requirements for Lightning Protection Systems and provide UL Master Label.

I. Conform to LPI-175, Lightning Protection Installation Standard and provide LPI-certified system.

J. Conform to NFPA 70, National Electrical Code.

K. Conform to the most stringent requirements when more than one standard is specified for products or installation.

1.6. WORKMANSHIP

A. Guarantee all materials and workmanship furnished and installed under this section of the specifications two years from the date of final acceptance of work. The Contractor also agrees that he will, at his own expense, repair and/or replace all such defective materials or effective workmanship which become defective during the term of this guarantee.

1.7. SEQUENCING AND SCHEDULING

A. Coordinate installation of lightning protection system with the installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection system, and building finishes.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturer's offering lightning protection components that may be incorporated in the Work include, but are not limited to, the following:

1. A-C Lightning Security, Inc.
2. Bonded Lightning Protection, Inc.
3. Dillon Lightning Protection Systems, Inc.
4. East Coast Lightning Equipment, Inc.
5. Harger Lightning and Grounding; Harger, Inc.
6. Heary Brothers Lightning Protection.
7. Independent Protection Company, Inc.
8. Robbins Lightning Protection, Inc.
9. Thompson Lightning Protection.

10. Warren Lightning Rod Company.

2.2. LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Lightning Protection System Products: Manufactured to NFPA 780, LPI-176, Lightning Protection System Material and Components Standard, and UL 96, Lightning Protection Components.

B. Air Terminals for Roof Mounting: Units with bases especially designed for the specified roof materials. Solid aluminum, with blunt points.

1. Air Terminal Bases: Cast bronze with bolt pressure cable connections and shall be securely mounted with stainless steel screws and bolts. Bases on modified bitumen roofs shall be secured with a proper adhesive.

2. For portions of the building under 75 feet in height, Class I materials may be used. Air terminals shall be 1/2-inch diameter extending a minimum of 10 inches above the protected object. Wherever the air terminal and base come in direct contact with aluminum, aluminum materials must be used.

3. Wherever materials come into direct contact with aluminum surfaces on buildings under 75 feet in height, the air terminals shall be 1/2-inch diameter aluminum extending a minimum of 10 inches above the object they protect.

C. Conductors:

1. Copper Cable Conductor: (Class I):

a. Twenty-eight strand copper cable.
b. Minimum 230 lbs. / 1,000 Linear Feet (LF).
c. Minimum 16 AWG conductors.
d. Minimum 1/0 AWG counterpoise.

2. Aluminum Cable Conductors (Class I):

a. Twenty-eight strand aluminum cable.
b. Minimum 115 lbs/1,000 Linear Feet (LF).
c. Minimum 14 AWG conductors.
d. Aluminum conductors for bonding or interconnecting metallic bodies to the main cable shall be 4 AWG aluminum wire in strength and cross section.
e. In all areas where the cable comes in direct contact with aluminum material, aluminum cable must be used to prevent electrolytic corrosion of the dissimilar metals.
f. Prohibited in contact with earth.
g. Prohibited where contributing to rapid corrosion.
h. Perforated strips shall not be used.

3. If the building has structural steel columns, the structural steel columns may be used as the down-conductors. Refer to Part 3 of this Section for installation requirements.

D. Ground Rods: Copper clad steel (10 mil finish) with a minimum of 7 percent of the rod weight in the copper cladding.

1. Diameter: 3/4 inch (19 mm).

2. Length: 10 feet (3 m).

E. Ground Plate: Solid copper, not less than 1/16th inch (2mm) thick.

F. Connectors and Splices - Exothermic, conforming to UL 96.

G. Ground Test Well: For accessible connection for testing. Ground test well shall be heavy duty 12-inch length (minimum) with cast iron lid and frame.

H. Roof Penetrations: Through-roof assemblies with solid bars and appropriate roof flashings.

I. Miscellaneous Components: Provide other components required for a complete lightning protection system such as bonding plates, terminal supports, clips, anchors, fasteners, bolts, nuts, screws, etc. All components shall conform to UL 96 for applicable classes.

1. Bonding plates shall not be less than 8 square inches of surface contact secured in place with stainless steel bolts.

J. Conduit: Provide 1-inch Type 40 PVC conduit for all down conductors. Refer to Division 26 Section, “Raceways and Boxes” for product requirements.

K. Waterproof Penetrations: The Contractor shall provide all waterproofing for the through-roof conduits, connectors, and other penetrations.

PART 3. EXECUTION

3.1. EXAMINATION

A. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive work.

B. Examine surfaces and conditions, with Installer present, for compliance with installation tolerances and other conditions affecting performance of the lightning protection system. Do not proceed with installation until unsatisfactory conditions have been corrected.

C. By beginning work, conditions are accepted with the responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

D. Lightning Protection System shall be provided with UL Master Label Certificate. Turn UL Master Label Certificate over to Owner upon system approval, and include one (1) copy of the same in the Operation and Maintenance Manual(s).

3.2. INSTALLATION

A. Install lightning protection systems according to manufacturer's written instructions.

B. Install components according to LPI-175, UL 96A, and NFPA 78.

C. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops. Run conductors in nonmetallic raceway, Schedule 40, minimum.

D. Conceal interior system conductors and down conductors.

E. Conceal exterior system conductors from normal view from exterior locations at grade within 200 feet (60 m) of building.

F. Support conductors every three (3) feet.

G. Notify Engineer at least 48 hours before concealing lightning protection system components.

H. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components, except those above single-ply membrane roofing.

I. Air Terminals on Specified roofing: Use adhesive recommended by manufacturer of air terminals and approved by manufacturer of roofing material. Comply with adhesive manufacturer's installation instructions. Maximum spacing of 25 feet.

J. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to the Lightning Protection System.

K. Bond ground terminals with counterpoise conductor located below grade.

L. Bond grounded media on building within 12 feet (4 m) of ground with counterpoise conductor located as indicated.

M. Bond grounded media on building within 1 foot (4m) of roof with counterpoise conductor.

N. Bond grounded media on building within 12 feet (4m) of roof with interconnecting loop at eave level or above.

O. Bond lightning protection system to grounded media on building at every 60 feet (18 m) with intermediate-level interconnection loop conductors.

P. Install the conductors as inconspicuously as practical and with the proper bends. Install conductors avoiding radius bends of less than 8 inches.

Q. Install the vertical conductors within the concealed cavity of exterior walls. Route the conductors to the exterior at elevations below the finished grade and make the ground connections to the earth outside of the building or stack perimeter.

R. Where shown, use the structural steel framework or reinforcing steel as the main conductor: Weld or bond the non-electrically-continuous sections together and make them electrically-continuous.

S. Protect copper conductors with stiff copper or brass tubing, which enclose the conductors from the top to the bottom of the tubing, between 300 mm (one foot) below and 2100 mm

(seven feet) above the finished grade.

T. Sheath copper conductors, which pass over cast stone. Cut stone, architectural concrete, and masonry surfaces with not less than a 2 mm (1/16-inch) thickness of lead to prevent staining of the exterior finish surfaces.

3.3. AIR TERMINAL INSTALLATION

A. Install per UL and NFPA requirements:

1. Rigidly connect to structure.

2. Make electrically continuous with roof conductors by means of pressure connectors or crimped joints.

3. At ends of structures, set 24-inches from end of ridge or edges and corner of roof.

4. Maximum spacing of 25 feet.

5. Prevent overturning by means of tripod or braces.

6. Uniformly space air terminals about the rim of the stack, not more than 24 inches from the corners or more than 8'-0-inches apart.

7. Air terminals on standing seam metal roof systems shall be secured with stainless steel clamps designed for standing seam metal roofing systems.

3.4. ROOF CONDUCTORS

A. Install per UL and NFPA requirements:

1. Connect directly to roof or ridge at 48-inch intervals.

2. Prevent sharp bends or turns.

3. Minimum bend radius of 8 inches.

4. Provide a downward or horizontal course.

5. All connections shall be electrically continuous.

6. Follow contours of flat roofs, ridges, parapets and edges.

3.5. DOWN CONDUCTORS

A. Installation:

1. Do not pass through non-conducting parts of structure.

2. Interconnect secondary conductors with grounded parts within the building.

B. Down Lead Conductors Run in Raceways:

1. All down lead conductors shall be run in 1-inch Type 40 PVC conduit.

2. All raceways shall be concealed wherever possible.

3. Bends shall be kept to a minimum and where used shall have an angle not to exceed 90 degrees.

4. Openings shall be free and clear.

5. Contractor shall provide conduits at various locations in the outer walls as required.

C. Provide a minimum of two down conductors located as widely separated as possible, at diagonally opposite corners.

D. Down lead cables shall not be brought directly through the roof. Through-roof assemblies with solid rods shall be used for this purpose.

3.6. INTERCONNECTION OF METAL PARTS

A. Metal ventilators shall be rigidly connected to the roof conductor at three places on the ventilator.

B. Metal bodies of conductance shall be protected if not within the zone of protection of the air terminals. All metal bodies having equal to, or greater than, 400 square inches shall be bonded to the lightning protection system using main size conductors and a bonding plate with not less than 3 square inches. Provisions shall be made to guard against corrosion due to joining of dissimilar metals. Provide air terminals on metals that are less than 3/16th-inch thick, which are not in the cone of protection on roof areas, such as ventilators, air conditioning units, etc., all as required by the stated Code.

C. All major rooftop mechanical equipment and isolated metal bodies within 6 feet of system conductors shall be bonded to lightning protections system's main roof conductor with secondary conductors and appropriate bonding devices. Do not penetrate airside housings for anchoring. Seal air and water tight all connections at mechanical equipment.

D. Interconnect conductive and inductive metals as required by the UL 96A Code.

3.7. GROUND CONNECTIONS

A. Use exothermic welding type connections which form solid metal joints in the main vertical and horizontal conductors, and for connections that are not exposed in the finish work.

B. Provide ground connection for each down conductor.

C. Metal water pipes and other large underground metallic objects shall be bonded together with all grounding mediums.

D. Ground connections shall be protected from mechanical injury.

E. In making ground connections, utilize permanently moist areas as applicable.

F. For the conductors located outside of the building, install the conductors not less than 2

feet (600 mm) below the finished grade.

G. Make connections of dissimilar metal with bi-metallic type fittings to prevent electrolytic action.

H. For structural steel buildings, connect the steel framework of the buildings to the main water pipe near the water system entrance to the building.

I. Connect exterior metal surfaces, located within 900 mm (three feet) of the lightning protection system conductors, to the lightning protection system conductors to prevent flashovers.

J. Do not pierce the structural steel in any manner. Connections to the structural steel shall conform to the UL Publication No. 96A.

K. Install ground connections to earth at not more than 1800 mm (60 foot) intervals around the perimeter of the building.

L. Weld or braze bonding plates, not less than 200 mm (eight inches) square, to cleaned sections of the steel and connect the conductors to the plates.

M. Connections to Lightning Protection System: Bond grounding conductors, including grounding-conductor conduits, to lightning protection down conductors or lightning protection grounding conductors in compliance with NFPA 750.

N. Common Ground Bonding with Lightning Protection System: Bond electric power system ground directly to lightning protection system grounding conductor at closest point to electric service grounding electrode. Use bonding conductor sized same as system grounding conductor and install in conduit.

3.8. GROUNDING ELECTRODES

A. Provide for each down conductor.

B. Drive into earth minimum of 10 feet. Ground rods shall be not less than 2 feet, nor more than 10 feet from the structure.

C. Ground rods shall be installed such that the top is not less than 2 feet below finished grade.

D. Ground rod resistance shall not exceed 10 ohms. The resistance of the entire grounding system shall not exceed 5 ohms.

E. Provide test wells installed flush with the finished grade.

F. Counterpoise shall be No. 1/0 AWG copper cable and shall be laid around the perimeter of the structure in a trench.

3.9. CORROSION PROTECTION

A. Use no combination of materials to form an electrolytic couple that will accelerate corrosion in the presence of moisture, unless moisture is permanently excluded from the junction of such materials.

B. Use conductors with suitable protective coatings where conditions would cause deterioration or corrosion of conductors.

3.10. FIELD QUALITY CONTROL

A. Periodic Inspection: Provide the services of a qualified inspector to perform periodic inspection according to LPI-177, Inspection Guide for LPI Certified Systems.

B. UL Inspection: Provide the services of Underwriters Laboratories, Inc. to perform inspections. Make revisions as required to obtain Master Label Certificate.

C. Certification: Two weeks prior to final inspection, deliver to the Owner four copies of the Certification that the installed lightning protection system has been inspected by a UL representative and has been approved by UL without variation.

D. Prior to commencement of any work, the Contractor shall obtain and deliver to the Owner the application and inspection forms necessary to file application for the LPI Certified System Certificates. As applicable, these forms include: Stage 1 - Grounding Inspection Report; Stage 2 - Concealed Components Inspection Report; and Stage 3 - Final Inspection Report.

E. The Contractor shall perform required inspections at the appropriate times and upon completion of the job shall forward the above Inspection Report forms to the Lightning Protection Institute to obtain the LPI Certified System Certificate.

F. Verify the electrical continuity by measuring the ground resistance to earth at the ground level, at the top of the building or stack, and at intermediate points with a sensitive ohmmeter. Compare the resistance readings. Ground resistance shall not exceed 5 ohms. Submit test results.

3.11. CONNECTIONS TO EXISTING SYSTEM

A. The new lightning protection system shall be connected to the existing lightning protection system as required to maintain UL certificate for existing systems (if applicable).

B. If existing system does not have UL certificate, new system still requires inspection and UL certificate.

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. This Section includes interior lighting fixtures, light sources, emergency lighting units, and accessories.

B. Related Sections include the following:

1. Division 26 Section "Network Lighting Controls" for programmable network lighting control systems.

C. Provide a lighting fixture for each fixture shown on the Drawings as described in this Specification, of the design and quality indicated herein. Provide fixtures complete, including lamps of the wattage and type indicated.

D. All materials, accessories, and any other equipment necessary for the complete and proper installation of all lighting fixtures included in this contract shall be furnished by the Contractor.

E. Conformance: Fixtures shall be manufactured in strict accordance with the Contract Drawings and Specifications.

F. Specifications and scale Drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.

G. Minor details, not usually indicated on the Drawings nor specified, but that are necessary for the proper execution and completion of the fixtures, shall be included, the same as if they were herein specified or indicated on the Drawings.

H. Omissions: The Owner shall not be held responsible for the omission or absence of any detail, construction feature, etc., which may be required in the production of the fixtures. The responsibility of accurately fabricating the fixtures to the fulfillment of this Specification rests with the Contractor.

1.3. SUBMITTALS

A. Product Data: Submit fixture shop drawings in booklet form with separate sheet for each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features, accessories, and the following:

1. Dimensions of fixtures.

2. Certified results of independent laboratory test for fixtures and lamps for electrical ratings and photometric data. Test data shall include manufacturer and model number for fixture being submitted.

3. Electronic LED Drivers.

4. Light Sources.

B. Shop Drawings: Show details of nonstandard or custom fixtures. Indicate dimensions, weights, method of field assembly, components, features, and accessories.

1. Wiring Diagrams: Detail wiring for fixtures and differentiate between manufacturer-installed and field-installed wiring.

C. Coordination Drawings: Reflected ceiling plans and sections drawn to scale and coordinating fixture installation with ceiling grid, ceiling-mounted items and other components in the vicinity. Include work of all trades that is to be installed near lighting equipment.

D. Samples for Verification: For lighting fixtures requested for sample submission by the Owner and/or Architect/Engineer. Refer to paragraph "Samples", in this Section, for additional information.

1. Lamps: Specified units installed.

2. Ballast: 120-V model of specified ballast type.

3. Accessories: Cord and plug.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

F. Record Documents: Accurately record actual location of each luminaire with the associated switching/control arrangement.

G. Maintenance Data: For lighting fixtures to include in maintenance manuals specified in Division 01. Include technical data sheets and parts ordering information. Include testing and maintenance requirements and instructions for emergency lighting equipment.

H. Lighting Calculations: Submit point-by-point lighting calculations for spaces where fixtures being submitted are not listed on the Interior Lighting Fixture Schedule on the Contract Drawings. All calculations shall strictly conform to IES Standards.

1.4. SAMPLES

A. After shop drawing review and prior to release for manufacturing, the Contractor shall furnish one sample of each fixture in this Specification for which sample is requested by the Architect and/or Engineer.

B. Shipping: The samples shall be complete with specified light sources and compatible driver(s), ready for hanging, energizing, and examining, and shall be shipped, prepaid by the Contractor, to the Architect/Engineer, or as otherwise advised.

C. Two weeks from the date received shall be allowed for thorough examination of the samples by the Architect/Engineer.

D. Return: Samples are returnable, the Contractor shall arrange for return, prepaid shipping and pickup of each sample submitted.

E. Samples must be actual working units of materials to be supplied.

F. Samples shall be submitted by the Contractor for each substituted lighting fixture as requested for review by the Owner and/or Architect/Engineer.

1.5. QUALITY ASSURANCE

A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction. Provide only UL listed and labeled fixtures with UL listed wiring. Wiring shall be suitable for the fixture temperature listing.

B. Comply with NFPA 70.

C. FM Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.

D. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

E. Mockups: Provide lighting fixtures for room or module mockups where required by the Architect. Install fixtures for mockups with power and control connections.

1. Obtain Architect's approval of fixtures for mockups before starting installations.

2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

3. Remove mockups when directed. Fixtures may be reinstalled in the Work with approval of Architect.

4. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. UL Listing: All fixtures shall be manufactured in strict accordance with the appropriate and current requirements of the Underwriters' Laboratories, Inc. (Standards for Safety), and others as they may be applicable. A UL listing shall be provided for each fixture type and the appropriate label or labels shall be affixed to each fixture in a position concealing it from normal view.

G. Installer: All Installers shall have not less than five (5) years' experience in the installation of lighting fixtures of the type and quality shown.

H. Materials, equipment and appurtenances, as well as workmanship provided under this Section, shall conform to the highest commercial standard as specified and as indicated on the drawings.

I. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 220, 410, and 510 as applicable to installation, and construction of interior building lighting fixtures.

J. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publication Numbers LE1 and LE2 pertaining to lighting equipment and LE4 pertaining to recessed luminaires.

K. IES Compliance: Comply with IES RP-1 pertaining to office lighting practices and RP-15, regarding selection of illuminance values for interior office building.

L. UL Compliance: Comply with UL Standards, including UL 486A and B, pertaining to interior lighting fixtures. Provide interior lighting fixtures and components which are UL-listed and labeled and comply with the following UL Standards:

1. UL 1598 – Luminaires (Tri-national standard)

2. UL 1993 – Self Ballasted Lamps and Lamp Adapters

3. UL 8750 – Light Emitting Diode (LED) Equipment for Use in Lighting Products

4. UL 8753/ULC-S8753 – Standard for Field-Replaceable Light Emitting Diode (LED) Light Engines

5. UL 8754/ULC-S8754 – Holders, Bases, and Connectors for Solid-State (LED) Light Engines and Arrays.

6. UL 935, UL 1029, UL 542 – Ballasts

7. UL 496 – Lampholders

8. UL 924 – Emergency Lighting and Power Equipment

M. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballasts Manufacturer's Association Standards and carries the CBM label.

N. NECA/IESNA Compliance: Comply with NECA/IESNA 500 – 1998 Standard, Installing Indoor Commercial Lighting Systems (ANSI).

1.6. COORDINATION

A. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system and other construction. Provide plaster frames, hangers, trim rings, and fittings, as required for each type of ceiling construction.

B. The Contractor shall coordinate switch and lighting control devices with door swings and other architectural features.

C. The Contractor shall be responsible for providing the required quantity of ballasts to provide the control and operations of the lighting fixtures as indicated by the lighting controls on the Drawings. For example, where two switches are indicated to serve fixtures, then two ballasts per fixture shall be provided.

1.7. WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty for Batteries: Written warranty, executed by manufacturer agreeing to replace rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Special Warranty Period for Batteries: Manufacturer's standard, but not less than 5 years from date of Substantial Completion.

C. Special Warranties for Electronic Drivers: Written warranty, executed by manufacturer agreeing to replace ballasts and drivers that fail in materials or workmanship within specified warranty period.

1. Special Warranty for Electronic Drivers: Five (5) years from date of manufacture, but not less than four years from date of substantial completion.

1.8. 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. LED Circuit Boards: 1 for every 50 of each type and rating installed. Furnish at least one of each type.

2. Plastic Diffusers and Lenses: 1 for every 50 of each type and rating installed. Furnish at least one of each type.

3. Electronic LED Drivers: 1 for every 50 of each type and rating installed. Furnish at least one of each type.

4. Emergency ballasts and/or automatic load control relays: 1 for every 50 of each type and rating installed. Furnish at least one of each type.

5. Globes and Guards: 1 for every 50 of each type and rating installed. Furnish at least one of each type.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not necessarily limited to, the products indicated on the “Interior Lighting Fixture Schedule” on the Contract Drawings.

1. The suitability of named (basis of design) fixture only has been verified. Alternate fixtures may be submitted for review, but shall be equal to or better in quality and

performance to that of named item, and must be suitable for application.

2. By providing other than named fixture, Contractor assumes full responsibility for all necessary adjustments.

3. Data listed and model number shown for each fixture type indicate minimum requirements and no exceptions will be made.

2.2. FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.

D. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.

2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

4. Laminated Silver Metallized Film: 90 percent.

E. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.

1. Plastic for lenses and diffusers shall be formed of colorless 100% virgin acrylic as manufactured by Rhom & Haas, Dupont, or as acceptable. The quality of the raw material must equal or exceed IES, SPI and NEMA Specifications by at least 100%--which, as a minimum standard, shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fade-meter or as tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years.

2. Lens Thickness: 0.125 inch (3 mm) minimum, unless greater thickness is indicated.

3. Glass used for lenses, refractors, and diffusers in lighting fixtures shall be tempered for high impact and heat resistance; the glass shall be crystal clear in quality with a transmittance of not less than 88%. For exterior fixtures, use tempered Borosilicate glass, Corning #7740, or as acceptable. For fixtures directly exposed to the elements and aimed above the horizontal with a radiant energy of 4.16 watts per square inch, or greater, use Vycor glass.

4. Where optical lenses are used, they shall be free from spherical and chromatic aberrations and other imperfections which may hinder the functional performance of the lenses.

5. Mechanical: All lenses, louvers, or other light diffusing elements shall be removable, but positively held so that hinging or other normal motion will not cause them to drop out.

6. Cleaning: All lenses shall be turned over to the Owner clean and free of dust.

F. Hardware: All hardware (e.g. screws, nuts, washers, latches, etc.) for fixtures located in damp/wet locations shall be stainless steel, unless otherwise indicated on the drawings.

2.3. FINISHES

A. Painted Surfaces: Synthetic enamel, with acrylic, alkyd, epoxy, polyester, or polyurethane base, light stabilized, baked on at 350 degree Fahrenheit minimum, catalytically or photo-chemically polymerized after application. All painted surfaces shall be painted after fabrication.

B. Ceiling opening frames shall either be manufactured of non-ferrous metal, or be suitably rust-proofed after fabrication.

C. Selection: Unless otherwise noted, finishes shall be as selected by the Architect.

D. Undercoat: Except for stainless steel, give ferrous metal surfaces a five-stage phosphate treatment or other acceptable base bonding treatment before final painting and after fabrication.

E. Unpainted non-reflecting surfaces shall be satin finished and coated with a stoved clear lacquer to preserve the surface. Where aluminum surfaces are treated with an anodic process, the clear lacquer coating may be omitted.

F. Unpainted Aluminum Surfaces: Finish interior aluminum trims with an anodized coating of not less than 7 mg per square inch, of a color and surface finish as selected by the Architect. Finish exterior aluminum trims with an anodized coating of not less than 35 mg per square inch or a color and surface finish as selected by the Architect.

G. Porcelain Enamel Surfaces: Apply porcelain finishes smoothly. Finish shall be not less than 7.5 mils thick of non-yellowing, white, vitreous porcelain enamel with a reflectance of not less than 85%.

H. Fixtures: Manufacturer's standard, unless otherwise indicated.

1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects. Metallic Finish: Corrosion resistant.

I. White finishes: Minimum of 85 percent reflectance.

2.4. LED ELECTRONIC DRIVERS

A. Manufacturers: Provide quality LED electronic drivers by the manufacturers listed below.

Off-brand/generic electronic drivers shall not be acceptable.

1. Advance (Philips Lighting Electronics)
2. eldo LED
3. General Electric (GE) Lighting
4. Lutron Electronics, Inc.
5. Osram Sylvania
6. Samsung
7. Universal Lighting Technologies, Inc.

B. General Requirements:

1. Suitable for operating type and quantity of LED sources indicated at full light output.
2. No PCBs.
3. Suitable for dry and damp locations.
4. Starting temperature: 0 degrees Celsius.
5. 50,000 hour (minimum) design life.
6. Class 2 output UL recognized to UL and CSA requirements.

C. Electrical Requirements:

1. 0-10V dimming standard, 1% minimum unless otherwise noted on the Contract Drawings.
2. Power Factor: 90 percent (0.9) minimum.
3. Total Harmonic Distortion (THD): Less than 20 percent.
4. Sound Rating: A.
5. Short circuit and overload protection standard.
6. Inherent thermal protection standard.

D. Listings:

1. ANSI C62.41: Category A for transient protection.
2. ANSI C82.11

3. FCC Part 15: Non-consumer equipment EMC.

4. UL 1310: Standard for Class 2 Power Units.

E. Warranty:

1. Minimum five-year warranty.

2.5. EMERGENCY BATTERY PACKS

A. Unless otherwise indicated, features include the following:

1. Conform to UL 924 “Emergency Lighting and Power Equipment”

2. Conform to NFPA 101 and International Building Code (IBC) requirements.

3. Initial Light Output: Provide as indicated.

4. Illumination time: 90 minutes, minimum.

5. Battery: Long life, high temperature, maintenance-free Nickel-Cadmium battery with test switch.

6. Self-Testing Diagnostics: Provide as indicated.

7. Cold Weather Operation: Provide as indicated.

8. Warranty: Minimum 5 year full product warranty.

9. Manufacturers: Provide specification grade emergency battery ballasts by the Manufacturers listed below. Off-brand/generic ballasts shall NOT be acceptable.

a. Bodine
b. Iota
c. Power Sentry

2.6. AUTOMATIC LOAD CONTROL RELAYS

A. Emergency transfer relays shall be double pole. Double throw with continuous duty rated coil in a NEMA 1 enclosure.

1. Units for individual lighting fixtures shall have contacts rated minimum 2.8 Ampere, 120/277 volt dual voltage input and be U. L. 924 listed.

2. All other units shall have contact rated minimum 20 amperes, 120/277 volt dual voltage input and all U. L. 924 listed.

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

1. Bodine

2. IOTA Engineering

3. Nine 24, Inc.

4. Side-lite

2.7. EXIT SIGNS

A. General Requirements: Comply with UL 924, "Emergency Lighting and Power Equipment", and the following:

1. Sign Colors and Lettering Size: Comply with authorities having jurisdiction.

B. Internally Lighted Signs: As follows:

1. Lamps for AC Operation: Light-emitting diodes (LED), 25 + years rated lamp life.

2.8. LED LIGHT SOURCES

A. Manufacturers: Provide quality LED light sources by the manufacturers listed below, off brand/generic light sources shall not be acceptable.

1. Cree

2. Nichia

3. Osram

4. Philips

5. Samsung

B. Correlated color temperature (CCT): As indicated on the Contract Drawings.

C. Light sources shall have a maximum deviation of 3-step Macadam Ellipses.

D. Color rendering index (CRI): 80 CRI minimum.

E. L70 rating shall meet or exceed value indicated on the interior lighting fixture schedule.

F. Light sources installed in outdoor environments shall be rated for low temperature applications (0°F, minimum).

2.9. FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Common Work Results for Electrical" and Division 26 Section "Hangers and Supports", for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (12-mm) steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (12-mm) steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.

D. Rod Hangers: 3/16-inch- (5-mm-) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

F. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

G. Recessed fixtures shall be removable from below to allow access to outlet/junction boxes in ceiling spaces.

H. Each fixture shall be supplied with necessary straps, supports, or hangers, or other miscellaneous materials and devices to install them in a satisfactory manner to conform to architectural treatment and finishes in area in which they are to be installed. Consult all Mechanical, Architectural and Structural Plans and related Contract Documents to be familiar with all necessary details for proper fixture placement. Failure to do so will not relieve the Contractor of responsibility of furnishing all necessary material, complete to perform function intended for indicated lighting system.

2.10. PROTECTIVE WIRE GUARDS

A. Provide protective wireguards over lighting fixtures subject to physical damage. All new lighting fixtures installed in, in mechanical and electrical rooms, and in areas subject to physical damage 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. Exit Signs

3. Emergency Lighting Units

4. Other Devices as required by Owner

C. Guards shall be fabricated from ¼-inch (9-gauge) cold-rolled steel rods, welded together with mounting tabs. Guards shall be finished with a powder-based epoxy to protect against corrosion. Finish color shall match the finishes for the area being installed.

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.

2.11. FIXTURES

A. Refer to “Interior Lighting Fixture Schedule” on the Contract Drawings.

PART 3. EXECUTION

3.1. INSTALLATION

A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.

B. Support for Fixtures independent of ceiling systems, ducts, and piping.

1. Install a minimum of two support system rods or wires for each fixture from structure above. Locate not more than 6 inches (150 mm) from fixture corners.

2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner.

3. Fixtures of Sizes Less Than Ceiling Grid: Arrange 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.

C. Suspended Fixture Support: As follows:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.

2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

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. Continuous Rows: Suspend from cable installed according to fixture manufacturer's written instructions and details on Drawings. Provide alignment fittings as required for uniform, level installation of continuous rows of suspended fixtures.

D. Fixture installations with fixtures supported only by insecure boxes will be rejected. It shall be the Contractor’s responsibility to support all lighting fixtures adequately, providing extra steel work for the support of fixtures if required. Any components necessary for mounting fixtures shall be provided by the Contractor. No plastic, composition or wood type anchors shall be used.

E. Setting and Securing: Set units plumb, square, and level with ceiling and walls, and secure according to manufacturer’s printed instructions and approved shop drawings.

F. Support for Recessed and Semi-Recessed Fixtures: Installed units may not be supported from suspended ceiling support system. Install ceiling system support rods or wires at a minimum of four rods or wires per fixture located not more than 6 inches from the fixture corners.

1. Fixtures Smaller Than Ceiling Grid: Install a minimum of two rods or wires for

each fixture and locate at corner of the ceiling grid where the fixture is located. Do not support fixtures by ceiling acoustical panels.

2. Fixtures of Sizes Less than Ceiling Grid: Center in the acoustical panel. Support fixtures independently with at least two 3/4-inch metal channels spanning and secured to the ceiling tees.

3. Recessed fixtures shall be provided with the proper plaster frame or suitable adapter to receive the finished ceiling construction.

4. Recessed lighting fixtures shall be suitable for the ceiling or wall material and construction in which they will be installed.

5. Recessed mounted lighting fixtures shall be connected to a junction box with flexible conduit. Final connection to light fixture shall be with heat-resistant wire.

G. Each lighting fixture shall be rigidly supported from the building construction and shall include suspension hangers, devices, and extra steel work for fixture support where required.

1. Support all lighting fixtures adequately. Special supports shall be installed as required.

2. Luminaires shall be furnished with all necessary stems, plaster frames, hangers, for the safe support of the fixture. All supports for fixtures shall be adequate to support weight of the fixtures. All visible hanging devices and appurtenances shall have the same finish as the fixture unless specifically indicated otherwise.

H. Coordinate with the work of other trades to determine modifications required to make fixtures suitable for ceilings as installed and verify the types of ceiling construction prior to fixture fabrication. Determine that the suspension method and the flange arrangement for the fixtures coordinates with the ceiling type and its suspended system. Fixtures which are shipped to the project and do not fit, or which otherwise do not match the ceiling system, shall be returned for correction at no additional cost.

I. Lamping: Lamp units according to manufacturer’s instructions.

J. Installation shall include receiving, checking, storage in a safe and approved area until they are required for installation, unpacking, assembly of separate fixture components where required, and complete wiring and connection including the provision of associated wiring and connection devices such as fittings, hangers, aligners, box covers, and similar hardware which may be required for certain fixtures, but are not detailed or scheduled with the fixtures.

K. Plaster frames or mounting frames shall be provided for all fixtures which require them and shall be suitable for the ceiling construction in which they will be installed.

L. Trim rings shall be painted to match the finish of the adjacent ceiling surface.

M. Fixtures in equipment rooms shall be positioned clear of equipment interference and yet provide adequate light for working around the equipment.

N. All lighting fixtures, when installed, shall be set free of light leaks, warps, dents, or other irregularities.

O. Pendant-type fixtures shall be hung at heights as required, and as shown on the Drawings.

P. Install all lamps required, including replacements for burned out lamps, until final acceptance of the completed work. No lighting fixture will be installed without lamps.

Q. If permanent lighting fixtures are to be used in lieu of temporary lighting facilities during the construction period, this shall be done only as permitted by the Owner's Representative, who may require that new lamps be installed and fixtures cleaned at the time of turnover to the Owner.

R. Lighting fixtures for general illumination, emergency lighting, and exterior lighting, shall be complete with all required accessories and attachments.

S. Fixtures shall bear UL label and shall be wired and installed in full compliance with applicable codes.

T. The omission of a type or quantity in the Interior Lighting Fixture Schedule on the Contract Drawings shall not relieve the Contractor of the responsibility of installing all required fixtures, of proper type, as shown on the Drawings.

U. Fixtures shall be recessed, surface, or pendant type, as specified and shall include sockets, diffusers, ceiling canopies and stems, hickeys, and all other necessary accessories.

V. Where suspended ceilings with steel channels occur, outlets and fixtures shall be supported on members resting on the channel framework. In no case shall fixtures be supported from plasterboard, plaster, or acoustic material.

3.2. GENERAL INSTALLATION OF FIXTURES

A. Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's Standard of Installation, NEMA Standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

B. All recessed fixtures mounted in dry wall or plaster ceilings shall be complete with a suitable plaster frame or trim ring. All fixtures shall be mounted on or in ceilings in accordance with published recommendations of the manufacturers using bar or swing-way hangers, etc. These items shall be furnished as part of the fixture whether called for by catalog number or not.

C. All fixtures shall be installed in strict accordance with NEC Article 410 and shall properly and suitably support the weight of any fixture installed. All fixtures shall be supported independently of ceiling suspension system being attached to building structure.

D. Every lighting fixture shall be of the type for the ceiling construction in or on which it is to be installed. It shall be the Electrical Contractor's responsibility to coordinate this with the Ceiling Contractor.

E. Install surface-mounted fixtures properly to eliminate light leakage between fixture frame and finished surface. Apply small bead of caulk or silicone around perimeter of fixture to conceal gaps between fixture and finished surface.

F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B, and the National Electrical Code.

3.3. CONNECTIONS

A. Ground equipment. 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.

3.4. FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Advance Notice: Give dates and times for field tests.

C. Provide instruments to make and record test results.

D. Tests: As follows:

1. Verify normal operation of each fixture after installation.

2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.

3. Verify normal transfer to emergency source and retransfer to normal.

4. Report results in writing.

E. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

F. Corroded Fixtures: Replace during warranty period.

3.5. CLEANING AND ADJUSTING

A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities, including emergency lighting units.

C. Touch up luminaire finish at completion of work.

D. Replace all light sources, drivers, etc. that fail within three (3) months of Substantial Completion.

3.6. DEMONSTRATION

A. Provide a minimum of four (4) hours of training and demonstration of luminaire operations, setting, aiming, adjustment, and maintenance.

END OF SECTION

DIVISION 26 SECTION 26 56 00
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 exterior lighting units with luminaires, lamps, ballasts, poles/support structures, and accessories.

B. Related Sections include the following:

1. Division 26 Section "Interior Lighting" for lighting fixtures installed on the exterior walls of the building.

2. Division 26 Section "Network Lighting Controls" for programmable lighting control systems controlling exterior lighting.

1.3. DEFINITIONS

A. Lighting Unit: A luminaire or an assembly of luminaires complete with a common support, including pole, post, or other structure, and mounting and support accessories.

B. Luminaire (Light Fixture): A complete lighting device consisting of lamp(s) and ballast(s), when applicable, together with parts designed to distribute light, to position and protect lamps, and to connect lamps to power supply.

1.4. SUBMITTALS

A. Product Data: Provide dimensioned and detailed drawings in booklet form with separate sheets for each type of lighting unit indicated, arranged in order of lighting unit type and designation. Include data on features, accessories, finishes, and the following:

1. Materials and dimensions of luminaires and poles.

2. Certified results of independent laboratory tests for fixtures and light sources for electrical ratings and photometric data. Include manufacturer and model number of fixture being submitted.

3. Light source initial and mean lumen output, average-rated hours of light source color temperature, and color rendering index.

4. Electronic Driver electrical characteristics, including voltages, operating and starting amperes, watts and watt losses, percent of allowable line voltage variation range, minimum starting temperature, and normal and maximum operating temperature.

5. Poles and standards dimensions, details of hand holes and wire entries, wind load and deflection, and finishes.

B. Shop Drawings: Anchor bolt templates keyed to specific poles and certified by manufacturer.

C. Record Documents: Accurately record actual location of each luminaire with the switching arrangements shown.

D. Maintenance Data: Submit maintenance data and parts list for each exterior lighting fixture and accessory; including trouble-shooting maintenance guide. Include that data, product data, and shop drawings in a maintenance manual; in accordance with requirements of Division 01.

1.5. QUALITY ASSURANCE

A. Luminaires and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for their indicated use, location, and installation conditions by a testing agency acceptable to authorities having jurisdiction.

B. ANSI/ASTM Compliance: Comply with applicable requirements of ANSI C2, National Electrical Safety Code.

C. FM Compliance: Units for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.

D. Comply with recommended practices of Illuminating Engineering Society (IES).

E. All products shall comply with UL and shall be UL listed.

F. Manufacturer's Qualifications: Firms regularly engaged in manufacture of exterior building lighting fixtures of types and ratings required, whose products have been in satisfactory use in similar service for not less than five (5) years.

G. Installer's Qualifications: Firm with at least three (3) years of successful installation experience on projects with exterior lighting fixture work similar to that required for the project.

H. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 25, 250, 410, and 501 as applicable to installation, and construction of lighting fixtures encompassed by this section.

I. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publication No. LE 2 pertaining to lighting equipment.

J. IES Compliance: Comply with IES RP-8, 19, 20, and PB-15 pertaining to exterior, parking, and roadway lighting practices and fixtures.

K. UL Compliance: Comply with requirements of UL Standards, including Standards 486A and B, pertaining to exterior lighting fixtures. Provide exterior lighting fixture and components which are UL listed and labeled and comply with the following UL Standards:

1. UL 1598 – Luminaires (Tri-national standard)

2. UL 8750 – Light Emitting Diode (LED) Equipment for Use in Lighting Products

3. UL 8753/ULC-S8753 – Standard for Field-Replaceable Light Emitting Diode (LED) Light Engines

4. UL 8754/ULC-S8754 – Holders, Bases, and Connectors for Solid-State (LED) Light Engines and Arrays.

L. NFPA Compliance: Comply with applicable requirements of NFPA 78, Lightning Protection Code, pertaining to installation of exterior lighting fixtures.

M. Code compliance is mandatory. Nothing in the Drawings and Specifications implies acceptance of work not conforming to these codes. Where work is shown to exceed minimum code requirements, comply with the Drawings and Specifications.

N. Codes and Standards: Provide luminaires, poles, standards and appurtenances conforming to the following:

1. American National Standards Institute (ANSI):

   a. C2: National Electrical Safety Code.

2. Conform to applicable sections of American Society for Testing and Materials (ASTM).

   a. B429: Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

3. Conform to applicable sections of Certified Ballast Manufacturer's Association (CBM) Standards for Fluorescent Lamp Ballasts.

4. National Electrical Manufacturers Association (NEMA):

   a. FA1: Outdoor Floodlighting Equipment.
   b. SH5: Tubular Steel, Aluminum, and Prestressed Concrete Poles.

5. Conform to applicable sections of National Fire Protection Association (NFPA) 70, National Electrical Code.

6. Underwriters Laboratories, Inc. (UL):

   a. 57: Electric Lighting Fixtures

7. Conform to all local requirements for maximum pole heights and pole setback distances from property lines.

1.6. DELIVERY, STORAGE, AND HANDLING OF POLES

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 poles until just before pole installation. Handle poles with web fabric straps.

D. Deliver exterior lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from construction debris and physical damage.

E. Store exterior lighting fixtures in original wrappings in a clean dry space. Protect from weather, dirt, fumes, water, construction debris, and damage.

F. Handle exterior lighting fixtures carefully to prevent damage, breaking, and scoring. Do not install damaged fixtures or components; remove units from site and replace with new.

G. Sequence exterior lighting installation with other work to reduce possibility of damage and soiling of fixtures during the remainder of the construction period.

1.7. WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, signed by Manufacturer and Installer agreeing to replace external parts of luminaires and poles exhibiting a failure of finish as specified below. This warranty is in addition to, and not a limitation of, other rights and remedies Owner may have under requirements of the Contract Documents.

1. Protection of Metal from Corrosion: Warranty against perforation or erosion of finish due to weathering.

2. Color Retention: Warranty against fading, staining, and chalking due to effects of weather and solar radiation.

3. Warranty Period: Manufacturer's standard, but not less than three years from date of Substantial Completion for poles, and not less than one year from date of Substantial Completion for luminaires.

1.8. 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. LED Circuit Boards: 10 for every 20 of each type and rating installed. Furnish at least one of each type.

2. Glass and Plastic Lenses and Covers: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

3. Electronic LED Drivers: 1 for every 20 of each type and rating installed. Furnish

at least one of each type.

4. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

1.9. COORDINATION

A. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not necessarily limited to, the products indicated on the "Exterior Lighting Fixture Schedule" on the Contract Drawings.

1. The suitability of named (basis of design) fixture only has been verified. Alternate fixtures may be submitted for review, but shall be equal to or better in quality and performance to that of named item, and must be suitable for application.

2. By providing other than named fixture, Contractor assumes full responsibility for all necessary adjustments.

3. Data listed and model number shown for each fixture type indicate minimum requirements and no exceptions will be made.

2.2. GENERAL PRODUCT REQUIREMENTS

A. Comply with IESNA RP 8 for parameters of lateral light distribution patterns indicated for luminaires.

B. Metal Parts: Free from burrs, sharp corners, and edges.

C. Sheet Metal Components: Corrosion resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

D. Housings: Rigidly formed, weather and light tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

E. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange to disconnect ballast when door opens.

F. Hardware: All hardware (e.g. screws, nuts, washers, latches, etc.) for fixtures in damp/wet locations shall be stainless steel, unless otherwise indicated on the Drawings.

G. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.

H. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.

2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

I. Lenses and Refractors: Materials as indicated. Use heat and aging resistant, resilient gaskets to seal and cushion lens and refractor in luminaire doors.

2.3. LUMINAIRES

A. Refer to "Exterior Lighting Fixture Schedule" on the Contract Drawings.

2.4. LUMINAIRE SUPPORT COMPONENTS

A. Description: Comply with AASHTO LTS 3 for pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

B. Wind Load Strength of Total Support Assembly: Adequate to carry support assembly plus luminaires at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 100 mph (160 km/h) with a gust factor of 1.3. Support assembly includes pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation. Strength Analysis: For each pole type and luminaire combination, 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.

C. Finish: Match finish of pole/support structure for arm, bracket, and tenon mount materials.

D. Mountings, Fasteners, and Appurtenances: Corrosion resistant items compatible with support components.

1. Materials: Will not cause galvanic action at contact points.

2. Mountings: Correctly position luminaire to provide indicated light distribution.

3. Anchor Bolts, Nuts, and Washers: Hot dip galvanized after fabrication unless stainless steel items are indicated.

4. Anchor Bolt Template: Plywood or steel.

E. Provide poles with mast arms, brackets, and bases as indicated on the Drawings. Poles shall meet all requirements set forth in this Specification. Substitutions shall match exactly the characteristics of the pole specified in this Specification.

F. Mast arms and pole-top mounting brackets for luminaires shall be manufactured specifically for the pole and luminaire submitted.

G. Coordinate with pole and luminaire manufacturers for assembly details, wind loading and vibration analysis, and compatibility of materials for electrolysis free attachment and

connection.

H. Structural and Mechanical Design: Use a safety factor of 5.0 for static and dynamic loading of load bearing components, including cable.

I. Concrete Pole Foundations: Size per Drawings. Design Strength: 3000 psig 20.7 MPa, 28 day compressive strength. Rub concrete to a smooth finish.

J. Handholes: Provide manufacturer's reinforced type removable weatherproof gasketed coverplate. Provide welded 2-inch (12 mm) threaded grounding lug centered approximately 12 inches above the base. Handholes shall have a minimum clear access opening of 2-1/2-inches x 5-inches, unless otherwise noted.

K. Base Cover: Each pole shall be provided with a base cover fabricated from the above-specified alloy. The cover shall be attached to the pole by means of tamperproof hardware.

L. Anchor Bolts: All anchor bolts shall be fabricated of hot rolled special quality carbon steel with minimum 50,000 psi yield strength, or as recommended by Manufacturer. Bolts shall be furnished with nuts and washers. All bolts and hardware shall be zinc electro-plated after fabrication.

2.5. LED ELECTRONIC DRIVERS

A. Manufacturers: Provide quality LED electronic drivers by the manufacturers listed below. Off-brand/generic electronic drivers shall not be acceptable.

1. Advance (Philips Lighting Electronics)
2. eldo LED
3. General Electric (GE) Lighting
4. Lutron
5. Osram Sylvania
6. Samsung
7. Universal Lighting Technologies, Inc.

B. General Requirements:

1. Suitable for operating type and quantity of LED sources indicated at full light output.
2. No PCBs.
3. Suitable for dry and damp locations.
4. Starting temperature: 0 degrees Celsius.
5. 50,000 hour (minimum) design life.

6. Class 2 output UL recognized to UL and CSA requirements.

C. Electrical Requirements:

1. 0-10V dimming standard.

2. Power Factor: 90 percent (0.9) minimum.

3. Total Harmonic Distortion (THD): Less than 20 percent.

4. Sound Rating: A.

5. Short circuit and overload protection standard.

6. Inherent thermal protection standard.

D. Listings:

1. ANSI C62.41: Category A for transient protection.

2. ANSI C82.11

3. FCC Part 15: Non-consumer equipment EMC.

4. UL 1310: Standard for Class 2 Power Units.

E. Warranty:

1. Minimum five-year warranty.

2.6. LED LIGHT SOURCES

A. Manufacturers: Provide quality LED light sources by the manufacturers listed below. Off brand/generic light sources shall not be acceptable.

1. Cree

2. NiCotia

3. Osram

4. Philips

5. Samsung

B. Correlated color temperature (CCT): as indicated on the “Exterior Lighting Fixture Schedule” on the Contract Drawings.

C. Light sources shall have a maximum deviation of 3-step Macadam Ellipses.

D. Color rendering index (CRI): 70 CRI minimum.

E. L70 rating shall meet or exceed value indicated on the “Exterior Lighting Fixture Schedule”.

F. Light sources shall be rated for low temperature applications (0°F, minimum).

2.7. FINISHES

A. Comply with NAAMM's Metal Finishes Manual for Architectural and Metal Products for recommendations for applying and designating finishes.

B. Provide finishes on poles, mounting arms/brackets, and luminaires as indicated on the “Exterior Lighting Fixture Schedule”.

2.8. SPLICES, TAPS

A. All splices underground in hand holes or other wet locations shall be waterproof and made with Scotchcast 85 Multi-Mold Splicing Kits, or approved equal.

B. All taps in pole bases shall utilize insulated connectors as specified in Division 26 Section, “Conductors and Cables”.

C. Tap wiring to luminaire shall incorporate Bus type HEB waterproof in line fuseholder with 12 AWG XHHW conductors as recommended by ballast manufacturer.

D. Splices in hand holes shall be supported on bricks 8-inches above bottom of handhole. Splices shall be kept to a minimum and are prohibited in locations other than hand holes, pull boxes or lighting unit bases, except for retaining circuitry of existing underground wiring where existing poles or wiring are distributed.

PART 3. EXECUTION

3.1. EXAMINATION

A. Examine areas and conditions under which roadway, parking and outdoor lighting fixtures are to be installed and substrate which will support lighting fixtures. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.2. FIELD COORDINATION

A. The Contractor shall be responsible for all field coordination, including verification of property lines, right of ways and other utilities.

B. Contractor shall locate poles and underground conduits within property lines. Contractor shall locate poles in compliance with local setback requirements.

3.3. DEMOLITION

A. Remove all existing lighting poles, fixtures, bases, and wiring which are indicated to be removed on the Drawings, and/or are obstacles to construction.

B. Re-use lighting poles and/or luminaires indicated to be relocated on the Drawings.

C. Turn over any removed lighting poles and/or luminaires that are not being relocated/re-used to the Owner.

3.4. INSTALLATION

A. Concrete Foundations: Construct concrete foundations with 3000 pound, 28-day concrete.

1. Comply with details for reinforcement and for anchor bolts, nuts, and washers. Verify anchor bolt templates by comparing with actual pole bases furnished.

2. Finish for Parts Exposed to View: Trowel and rub smooth. Comply with Division 03 Section Cast in Place Concrete for exposed finish.

B. Install poles in compliance with ANSI C2, with Manufacturer's written instructions and as follows:

1. Use web fabric slings (not chain or cable) to raise and set poles.

2. Mount pole to foundation with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

3. Secure poles level, plumb, and square. Provide shimming and grouting of pole base to maintain luminaire in a true vertical position.

4. Grout void between pole base and foundation. Use nonshrinking or expanding concrete grout firmly packed in entire void space.

5. 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.

C. Luminaire Attachment: Fasten to indicated structural supports.

D. Luminaire Attachment with Adjustable Features or Aiming: Attach luminaires and supports to allow aiming for indicated light distribution.

E. Lamp luminaires with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

F. Install exterior lighting fixtures at locations and heights as indicated in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's Standard of Installation, NEMA Standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

3.5. UNDERGROUND DUCT LINES

A. Duct lines shall be polyvinylchloride (PVC) heavy wall plastic ducts for installation without concrete encasement.

B. Conductor AWG size shall be as indicated on the drawings, minimum 10 AWG. Conductors shall be type THW. Provide for each lighting branch circuit shown on the

Contract Drawings, a separate green grounding conductor sized in accordance with NEC.

C. Duct lines shall be installed in a trench minimum 24 inches below grade. Trench shall be cleaned of all rock, gravel or debris larger than 1/4 inch diameter. Duct lines shall rest on minimum 3-inch clean sand bed and shall have minimum 3 inches clean sand over cover. Trench earth backfill shall be free of rock, gravel or other debris. Open trenches shall be limited to 50 linear feet before backfilling.

D. Metal conduit sleeves of sufficient size shall be installed in concrete lighting standard bases to allow the entry/exit of branch circuit wiring. Sleeves shall be capped with bushings.

E. All elbows and all ducts installed above grade shall be rigid galvanized steel.

3.6. CONNECTIONS

A. Ground equipment: 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.

B. Ground metal poles/support structures and fixtures according to Division 26 Section “Grounding and Bonding”.

1. Bond metallic components of lighting fixtures, poles, and foundations. Connect luminaires to grounding conductors routed with associated branch circuit phase and neutral conductor(s) and to grounding electrode with 4 AWG conductor.

2. Provide 10-foot (3-m) driven ground rod at each pole, exothermically welded to grounding conductor.

3.7. FIELD QUALITY CONTROL

A. Inspect each installed unit for damage. Replace damaged units.

B. Tests and Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with power source, and as follows:

1. Check intensity and uniformity of illumination.

2. Check electronic LED drivers and circuit boards for proper operation.

C. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

D. Set, adjust, and aim adjustable fixtures at night. Repeat procedure until units provide illumination acceptable to the Owner.

3.8. CLEANING AND ADJUSTING

A. Clean units after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable luminaires and luminaires with adjustable lamp position to provide required light distributions and intensities, in night test of system. Verify that measured illuminance

values comply with isolux plot diagram values and point-by-point calculations.

C. Touch up damage to finishes.

3.9. DEMONSTRATION

A. Upon completion of installation of exterior lighting fixtures and associated electrical supply circuitry, apply electrical energy to circuitry to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

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/TIA-607-C: 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. All systems and equipment must comply with the Delaware State-Wide Information Technology and Architecture Standards, Latest Version.
2. Contractor shall outfit all telecom rooms according to T Drawings. Racks and other termination and distribution fields shall be installed according to manufacturer's guidelines and industry standards.
3. TR and TER layouts shall be approved by school 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.

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 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. 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. Proposed product is fully documented and properly submitted.
   e. Proposed product has received necessary approvals of authorities having jurisdiction.
   f. Proposed product is compatible with and has been coordinated with other portions of the Work.
   g. 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. 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. Installer's warranty shall guarantee workmanship for a period of one year, 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. Distribution Racks and Cabinets

1. Floor Mounted Free Standing 2 Post Racks
   a. Hubbell HPW84RR19D 84" X 6" Equipment Rack with
      i. Hubbell HC219CE3N 2U Horizontal Manager
      ii. Hubbell XS1010 Vertical Cable Manager
   b. Or approved equal from Cooper B-Line, Ortronics, Systimax or Leviton.
2. Floor Mounted Free Standing 4 Post Racks
   a. Four post aluminum frame with EIA rails
   b. 45 Rack Units
   c. Black
   d. Similar to Ortronics OR-MM67SVR or approved equivalent.
3. Floor Mounted Equipment Cabinet
   a. The cabinet frame shall be constructed of four cold rolled steel components – top, bottom, left and right welded to form a self-supporting framework. The side members shall be fabricated from 16ga cold rolled steel. The top and bottom shall be fabricated from 14ga cold rolled steel. The vertical uprights shall have integral cable management channels with provisions for hook and loop or traditional cable ties. The frame shall be bolted to the floor, and side by side to other frames.
   b. The side covers shall be constructed of 19ga cold rolled steel with double bent flanges along the entire perimeter. The side covers shall lift off easily via grip handles assembled to the covers. The side cover shall have clusters of rectangular perforation to accommodate ventilation for equipment providing greater than 100 sq. in. of ventilation.

c. The front door shall be a window door assembled to the frame via spring-loaded hinges at the top and bottom. The door shall be locking with a unique operator's key. The operator's key shall operate the front door only. The latch shall be flush to the door. The window shall be a .125" acrylic panel secured to a reinforced steel frame.

d. The rear door shall be a steel door assembled to the frame via spring-loaded hinges at the top and bottom. The door shall be locking with a unique service personnel key. The service personnel key shall operate both the rear and front doors. The latch shall be push button operated. The rear door shall be reinforced and have a cluster of rectangular perforations for ventilation.

e. The top shall have a removable panel in the center, designed to be replaced with a cooling fan, and six 3" diameter cable entry knockouts; three along each side to route cables directly into vertical cable organizers minimizing the number of bends to the cables.

f. The bottom panel shall be similarly configured with 6 knockout locations. The cabinet bottom shall also be provided with holes for securing the cabinet to the floor.

g. The top cover shall accept the mounting of a 250 CFM cooling fan.

h. The cabinet shall be pre-configured for 19" mounting with universal hole spacing per EIA 310 D. The cabinet shall feature three sets of rails, front, center, and rear. The front set of rails shall be 20 rack positions high, from the bottom of the cabinet. The rear and center rails shall be the full internal height. The recess of all three sets of rails shall be adjustable forward and back. The rails shall be tapped for a #10-32 screw. The center rails shall be formed in a 'C' profile, 3" deep tapped on both the front and rear flanges so as to provide the functionality of an open frame rack. The front and rear rails shall be an L shape.

i. The entire enclosure shall be finished with a durable polyurethane powder coat – medium texture and shall be available in black.

4. 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.

5. Racks, cabinets and other termination equipment shall be properly secured to floor with appropriate anchors and bonded to Telecommunications Grounding System.

6. Unit shall be similar to Ortronics OR-DCC422846-00002 or approved equivalent.

7. Provide (1) 8-port transient surge protection strip for each TR and per rack/cabinet in the TER and TRs.

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 or approved equivalent

Vertical Cable Management

d. Vertical Cable management shall be provided for all racks. Provide 2 for each rack or cabinet.

e. Cable management shall be – Ortronics OR-60400510, or approved equivalent.

C. Wiremesh Cable Tray

Cablofil CF 54/3300

Cablofil CF 105/300

D. 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.

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 Gangable Gang Boxes for low voltage:
   a. Hubbell HBL985 Two Gang Box
   b. Hubbell HBL986 Three Gang Box
   c. Hubbell HBL989 Low Voltage Partition

G. Surface Mounted Raceway (SMR)

1. Surface mounted split channel raceway for power and data - Wiremold 4000
   a. Coordinate all Wiremold for telecom equipment with electrical installer.
   b. Provide associated colored connectors (see 271000) and faceplates per manufacturer's recommendations for telecommunications.
   c. Coordinate color and finish with architect prior to installation

H. Floor Boxes and Poke-through Device

1. Small Capacity In-floor box
   a. Coordinate all floor boxes and poke-through devices for telecom equipment with electrical installer.
   b. Floor box shall meet latest UL standards for scrub water resistance
   c. Four-Compartment Combination Box similar to Wiremold RBF4 or Wiremold RFB6
   d. Top of box shall allow for matching floor finish insert and be constructed of metal
   e. Provide all brackets and accessories for proper telecommunications installation.
2. Large Capacity In-floor box
   a. Wiremold Evolution Series EFB6S with flush mounted cover.
3. Poke through
   a. Unit shall be similar to Wiremold Evolution Series with 5 gangs.

I. Distribution Backboard

1. Plywood
   a. ¾" 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.

J. Electrical Protection for Telecommunications

1. Telecommunications Main Grounding Busbar (TMGB) and Telecommunications Grounding Busbar (TGB)

a. Provide one TMGB in the Telecommunications Equipment Room as shown on T Drawings.

b. Provide a TGB 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.

K. UPS Equipment

1. Tripplite SMART3000RM2UN
2. Tripplite SU2200RTXLCDN

L. Rack mounted power strip

1. Provide 8 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 TIA/EIA 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 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. Termination Equipment for Telecommunications

D. Faceplates and Outlets

E. Classroom / Conference / Collaboration A/V Cabling

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-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/TIA-607-C: 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.

1.04 SYSTEM DESCRIPTION

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 10Base-SX

ii. Ethernet 100Base-FX

iii. Ethernet 1000Base-SX

iv. Ethernet 1000Base-LX

v. Ethernet 10GBase-S

vi. Ethernet 10Base-LX4

vii. Ethernet 10GBase-L

viii. Ethernet 10GBase-LRM

ix. Fibre Channel 100-MX-SN-I

x. Fibre Channel 100-SM-LC-L

xi. Fibre Channel 200-MX-SN-I

xii. Fibre Channel 200-SM-LC-L

xiii. Fibre Channel 400-MX-SN-I

xiv. Fibre Channel 400-SM-LC-L

xv. Fibre Channel 1200-MX-SN-I

xvi. Fibre Chanel 1200-SM-LL-L

xvii. FDDI PMD ANSI X3.166

xviii. FDDI SMF-PMD ANSI X3.184

b. All wiring including copper and fiber optic employs a star topology.

i. Category 6 UTP wiring terminates on Category 6 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 building as shown on T-Drawings. Drop to outlet installed in conduit and wall box, or dual-channel

surface mounted raceway 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 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 version 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 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 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. Inner duct and accessories.
5. Rack configurations and wiring diagrams.
6. Network cabling test equipment and process (routines).

7. Equipment Racks
8. 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 Design consultant.

ii. Provide multiple outlet samples where required to accurately represent range of outlets to be provided.

D. Shop Drawings
1. The Contractor shall submit shop drawings of all systems showing major 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 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, 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.

1.07 WARRANTY

A. Installer’s Warranty: Provide manufacturer’s system warranty against electrical or mechanical defects for 1 year from 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 except as noted in T-series Drawings.

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. 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 portion of the cabling system shall comply with the link and channel performance requirements of ANSI/TIA 568-B.2-1 "Performance Specifications for 4-pair 100 Ohm Category 6 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 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 such services 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. 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 areas without cable tray above false ceilings.

2.03 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 C6SPxx
2. Hubbell C6RPxx
3. Hitachi 30025-8
4. Hitachi 30024-8
5. Or approved equal from
   a. Belden
   b. Berk-Tek
   c. Systimax

2.04 BACKBONE CABLES

A. Multi-pair Cat 5e Riser Cables
   1. Hitachi 30093-50
   2. Hitachi 30172-100
   3. Or approved equal from
      a. Mohawk
      b. Belden
      c. Berk-Tek

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

2.05 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 50/125um OM4 Aqua
2. Hubbell FCLC900K50GM12 9/125 UPC
3. Or approved equal from
a. Ortronics
b. Panduit
c. Systimax
d. Leviton

F. 110 Blocks
1. Hubbell 110BLK50FTK5
2. Hubbell 110BLK100FTK5
3. Hubbell 110BLK300FTK5
4. Or approved equal from
a. Ortronics
b. Panduit
c. Systimax
d. Leviton

2.06 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. Hubbell IFP11xx
2. Hubbell IFP12xx
3. Hubbell IFP13xx
4. Hubbell IFP14xx
5. Hubbell IFP16xx
6. Hubbell IFP26xx
7. Hubbell IFP29xx
8. Hubbell IFP212xx
9. 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

2.07 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

2.08 CLASSROOM / CONFERENCE / COLLABORATION A/V CABLING
A. The instructor's station "L" and "M" assembly shall include the following cables. (see T series drawings for exact cable types and connections)
1. Audio

a. 3.5 MM Stereo terminated connectors
b. 18/2 AWG Speaker Wire
2. HDMI & USB
a. Hubbell IMH110ST2W HDMI Extender
b. Hubbell IMU11015xx USB Extender
c. Hubbell AVPS15W with 5V DC Output to ISFHDBT3W
3. Control and Signal
a. Cat 6 UTP
4. AV Patch and Jumper Cables
a. Provide 3.5 mm cables from faceplates to devices
b. Provide HDMI from faceplates to devices
c. Provide USB from faceplates to devices
d. Provide HDMI for owner provided Apple TV at each display device.
i. Provide and install Velcro straps and install owner provided Apple TV to display device.
ii. Coordinate with owner.
e. Provide a plug-in Y power splitter at each display device.

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 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 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. 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 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 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. 10 feet of service loop shall be provided in the ceiling at each workstation. Contractor 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. 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. Cable 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.

B. Determine allowable cable proximity to other electrical power sources of 480 Volts or less using TIA/EIA-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	< 2kVA	2-5 kV	> 5 kVA
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.

C. Interior Fiber Optical Cable Installation Requirements

1. Install all interior fiber optic backbone cables in 1-inch plenum-rated inner duct, similar to Pyramid Industries #PLM100(T) where fiber optical cable placed in cable tray or otherwise fully supported in accordance with manufacturer's requirements.
2. Install all outdoor rated communications cables not rated for plenum placement in interior environments in metallic conduit, according to NEC Articles 770 and 800.
3. Install inner duct 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.
4. Provide pull strings or ropes in all conduit and inner duct used for communications cables.

D. 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 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, cable 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. 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 roof or exterior of 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.

E. Install all cable 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 busbar in each telecom room. Each telecom room shall be interconnected to TER with #3 AWG bonding backbone to TMGB per Telecommunications Grounding Diagram. It shall be left to licensed electrician to interconnect TMGB with lowest point of building ground. Contractor shall verify TMGB has been bonded to building ground before declaring completion.

F. 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 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-Builts

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. 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 1-Year Installers warranty has been given to a school district Technology representative.
7. Submit Manufacturers Extended Warranty Application.

END OF SECTION

SECTION 27 40 00
AV SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes

1. Classroom Sound Enhancement System
2. Conference Spaces
3. Electronic Displays

1.02 DEFINITIONS

A. "Sound Enhancement" refers to a stand-alone sound system which includes speakers, speaker wire, an infrared microphone and receiver, a pendant style microphone and amp/mixer unit.

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.

1.03 SYSTEM DESCRIPTION

A. Design Requirements

1. Classroom Sound distribution through a pendent style portable microphone and at least one hand held microphone per learning area.
2. Amplifier/Receiver must have audio inputs for at least three auxiliary devices and an additional input to allow transmitting of sound to ceiling speakers from the microphone.
3. All stand-alone sound systems must have call override from the Intercom/PA system in the case of an emergency.
4. Installed and active electronic displays coordinated with cabling and equipment from other specification sections.

B. 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/TIA-607-C: 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. All systems and equipment must comply with the Delaware State-Wide Information Technology and Architecture Standards, Latest Version.

C. Product Data: Submit manufacturer's product literature, technical specifications and similar information for the following items demonstrating compliance with the specified requirements.

1. Sound Amplifier
2. Sound Speakers
3. Sound Cabling
4. Electronic Displays and associated mounts.

D. Shop Drawings

1. The Contractor shall submit shop drawings of all systems showing major 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 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.

1.05 QUALITY ASSURANCE

A. All Work shall be installed in a first class, neat and professional 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 cabling system specified in this Section, 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 1 year from date of final acceptance.

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.

PART 2 - PRODUCTS

2.01 MATERIALS – ALL MATERIALS SHALL BE NEW AND UNUSED

A. J-Hooks

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

B. Electronic Displays

1. 65” LCD Display (No substitutions)
   a. Smart 6265 Smart Panel with adjustable mount
2. 42” LCD Display
   a. NEC V404
3. Wall Mounted Interactive Projector (No substitutions)

a. Epson Brighlink 695wi

C. Classroom Sound Equipment (Lightspeed 955 Access) No Substitutions

1. Receiver / amplifier specifications
   a. Power output: 20W
   b. Frequency response: 60 Hz to 7 kHz
   c. Power supply (UL Listed): 24V/2.5A
   d. Total Harmonic Distortion: <1% @ 10 Watts
   e. Controls:
      i. Power switch with LED
      ii. Auxiliary audio input volume controls
      iii. Speaker on/off switches for zoning
      iv. Mixed audio output level controls
   f. Page mute sensitivity level control
   g. Connections:
      i. Speaker outputs (Euro-block connectors)
      ii. Mixed audio inputs (3.5mm)
      iii. DC Power input
      iv. Page mute input (Euro-block)
   h. The receiver/amplifier shall be manufactured using lead-free processes and free of other materials harmful to the environment (RoHS compliant).
   i. The receiver/amplifier shall be CE certified.
2. Pendant-style ir microphone / transmitter
   a. Description: the pendant-style transmitter shall be capable of being worn around a teacher's neck as a hands-free microphone via the lavaliere cord or to be used as a handheld student pass-around microphone. The mic must be rechargeable via cradle charger and must have alkaline charge protection.
   b. 1.9 GHz Wireless Communication
   c. Audio distortion: <1%
   d. Battery Charger: cradle charger
   e. Battery Power: One 2.4V NiMH battery pack
   f. Dimensions: 2.9" (h) x 1.1" (w) x 1.0" (d)
   g. Weight (with battery): 1.8 oz.
   h. The pendant-style transmitter shall be manufactured using lead-free processes and free of other materials harmful to the environment (RoHS compliant).
   i. The pendant-style transmitter shall be CE certified.
3. Page First Clip
   a. Unit shall provide shunt of local sound.
4. Speakers
   a. Ceiling Speaker (four speakers for rooms of 1600 sq. ft. or less)
   b. Description: two-way speaker system

c. Driver Size: 6.5” driver; 1” tweeter
d. Frequency Response: 40 Hz – 20 kHz ± 6dB
e. Impedance: 8 Ω
f. Power Handling: 30 W
g. Enclosure: white ABS ceiling-mount housing with metal grille; ABS back-enclosure
h. Tile Support: 20-gauge metal tile bridge

5. Cable
   a. Speaker Cable:
      i. Class 2, or better plenum rated. (16/2 AWG shielded)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine conditions under which AV cabling and sound enhancement 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 Communications Services: Ensure all telecommunications systems (voice, video and data) remain operational throughout the project.

1. Identify any additional outlets, circuits, and 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 AV cabling and sound enhancement equipment systems, including (but is not limited to) connectors, electronics, terminators, pass-thrus, cables etc…

1. Cable runs shall be factory terminated. Splicing of any cable is prohibited
2. Secure all 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. Verify all horizontal cable run lengths prior to installation. Ensure cables do not exceed distances that would degrade the signal transmission requirements
6. Do not support cables from ceiling grid T-Bars, grid wire supports or bridle rings. Do not allow cables to touch ceiling grid.
7. Install cables in EMT in all unfinished or exposed areas
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. Place cables in compliance with ANSI/TIA/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. Communications outlets shall be located to be no more than 6 feet from an electrical outlet.

B. Determine allowable cable proximity to other electrical power sources of 480 Volts or less using TIA/EIA-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	< 2kVA	2-5 Kva	> 5 kVA
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.

C. Install all cable in accordance with National, state and local codes and TIA/EIA Standards, and BICSI methods.

1. Follow manufacturer's guidelines and requirements for all cable termination.

D. Permanently identify all system components following TIA/EIA-606A "Administration Standard for Commercial Telecommunications Infrastructure" with identification format:

1. Identification: Provide permanent identification labels for outlets, faceplates and cables.
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. Sound Systems

1. The contractor shall test all aspects of the Systems once it is installed and demonstrate these functions to the owner of owner's representative.
   a. Speaker levels shall be verified to function individually and as a unit.
   b. Control of the system shall be shown to control all aspects of the systems.
   c. Levels shall be set for all outputs.
   d. Microphones shall be demonstrated to work as intended by the manufacturer.

3.05 AS-BUILTS

A. As-builts shall be provided by the contractor in hardcopy and electronic CAD format prior to completion.

B. As-builts by contractor must include parts lists and wiring diagrams that clearly indicate all equipment, locations, wiring and connections.

C. Owner's manuals shall be supplied as part of the as-built documentation.

3.06 DEMONSTRATION AND TRAINING

A. All aspects of the systems must be demonstrated for the owner at the time of training

B. A minimum of 16 hours of training shall be provided.

C. Training shall be video and audio recorder for the owner and turned over to the owner at acceptance.

3.07 ACCEPTANCE

A. 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 functions have been tested and documented to function as designed and per the manufacturer's recommendations.
3. All punch list items have been reconciled.
4. All disturbed ceiling panels, fire stopping materials, covers, etc. have been properly reinstalled.
5. A 1-Year Installers warranty has been given to a school district Technology representative.
6. Submit Manufacturers Extended Warranty Application.

END OF SECTION

SECTION 27 50 00
INTERCOM AND CLOCKS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes

1. This section and associated drawings define a communications system for an intercom, public address and master clock system. The contractor shall provide all infrastructure, cable, hardware and equipment as defined to provide complete and operational systems.

1.02 SYSTEM DESCRIPTION

A. Design Requirements

1. Intercom/PA/Master Clock System

a. The facility intercommunication system shall be a low voltage system that utilizes a fiber and copper cable infrastructure to distribute a user-defined input in a single and bi-directional manner. The system shall be capable of multiple, simultaneous conversations on separate channels throughout the facility through VoIP telephones and loudspeaker assemblies.

b. A programmable master for tone distribution schedule shall also be included as part of the overall system.

c. The system shall be microprocessor based and have interconnection with the telephone system installed within the facility. In addition, the system must be expandable to meet the user's future expansion needs and be programmable from a computer terminal located at the facility.

d. The clock system shall consist of a master unit and slave clocks. The system shall be wirelessly corrected and have battery powered clocks. All clocks shall be corrected wirelessly to the master clock system.

B. Performance Requirements

1. Rack/Cabinet mountable headend equipment.
2. Announcement distribution from a central location to zones, individual classrooms, groups or all facility speakers.
3. Broadcast of user defined input (radio signal, compact disc, aux input, etc.) to zones, individual rooms, groups or all facility loudspeakers.
4. Emergency cut-in to all speakers in an emergency situation from a central location.
5. Two-way intercommunication between the central rack, any call-in location or any selected two-way speaker location.
6. Hands free communications by means of a loudspeaker or speakerphone used as a transducer or speaker/microphone combination.
7. Visual and audio monitoring of all intercommunication system activity.
8. Volume and level controls for all centrally located intercommunication system equipment.
9. Tone distribution based off the master clock that can be partitioned into zones.
10. Capability to tie into any auxiliary sound system throughout the facility.
11. High priority call-in from any telephone/call switch in an emergency situation.

C. Regulatory requirements

1. All work will conform to the National Electric Code and applicable local ordinances.

1.03 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. Submit the shop drawings, product data and quality control submittals specified below at the same time as the package
2. Shop Drawings shall include the following items but are not limited to:
   a. Equipment and device quantities and types
   b. Wire types
   c. System wiring diagrams showing all connections
   d. Drawings including all equipment locations
   e. Associated equipment specifications and cut sheets
   f. Product data including catalog cut sheets, manufacturer's default specifications, user operation guides and a bill of materials

C. Quality Control Submittal

1. Submit the name, address and telephone number of the nearest fully equipped service organization.
2. Submit a certificate of completion of installation and service training from the system manufacturer.
3. 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."

D. 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.

1.04 AS-BUILTS

A. All systems must have as-built drawings provided in electronic CAD and hardcopy format that clearly show all system components, wiring schemes and system interconnections.

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 personnel. Any work found to be of inferior quality and/or workmanship shall be replaced and/or reworked until the approval of the school systems is obtained.

B. Qualifications

1. Installer
   a. Must be qualified to cable, terminate, install and program the equipment specified in this Section, 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.

1.06 WARRANTY

A. Special Warranty: Provide manufacturer's system warranty against electrical or mechanical defects for 1 year from date of final acceptance.

1. 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
2. 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. 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.

B. All passwords and software must be included for the system.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable manufacturers

1. The intercom and clock systems shall be manufactured by the same manufacturer as is already installed within the main building and be an extension of that system.
2. Substitutes
   a. Any proposed substitute must have identical system architecture and function in an identical manner to the designed solution.
   b. Burden of proof rests on the submitting contractor to provide information that the proposed substitute meets the design criteria.

2.02 MATERIALS

A. J-Hooks

1. Cooper B-Line BCM-21, 23 or 64.
   a. Provide in sufficient quantity for 15% future expansion.
   b. Installed no more than 6' apart.
   c. Install in any areas without cable tray above false ceilings.

B. Compact Rack System

1. Rack Mount full, Mini-System, or Wall Mount panel. Shall include the following components:
   a. Processor Card
   b. Analog Card
   c. Station Card
   d. Telephone Interface Card

e. 5 volt / 12 volt Power Supply
f. 26 volt Power Supply(s)
g. Audio Program Module Interface Assembly

2. Wall Mount mounting mainframe. Utilizes convection cooling and the following circuit cards:
   a. Processor Card
   b. Analog Card
   c. Station Card
   d. Telephone Interface Card

C. Relay Cards
   1. Relay Module/Card

D. Program Sources
   1. 5-Disc CD Player
   2. AM/FM Tuner
   3. Desktop Paging Microphone

E. Power Amplifiers
   1. 60-Watt Amplifier
   2. 125-Watt Amplifier
   3. 250-Watt Amplifier

F. Station Equipment
   1. Administrative Display Phone
   2. Administrative VoIP Phone
   3. Administrative Wall-Mount Phone
   4. Administrative Desktop Phone
   5. Secure Call - Call Assurance Call-in Switch
   6. Call switch with Privacy
   7. Rocker-style Call Switch

G. Optional Equipment
   1. Telephone Access Card
   2. Telemedia Control Unit
   3. Television Control Unit
   4. Handheld Infrared Transmitter

H. Administrative Phone
   1. Admin phones shall be :
      a. MCDS4 – Administrative Display Phone
      b. QSIP1 – Administrative VoIP Phone (Desk or Wall)

I. Call Staff Stations
   1. Staff Stations shall be Bogen Model:
      a. SC1 – Secure Call - Call Assurance Call-in Switch
      b. CA21B – Call Switch with Privacy

J. Intercom System Speakers
   1. Classroom Speakers shall be Bogen:
      a. Drop-in Ceiling Speakers: CSD2X2VR/U Drop-In Ceiling Speakers
      b. Cut-in Ceiling Speakers: S86T725PG8U
      c. Wall Speakers: MB8TSQ/SL Metal Box Speakers
   2. Hallway Speakers shall be Bogen:
      a. Ceiling Speakers: CSD2X2VR/U Drop-In Ceiling Speakers
      b. Cut-in Ceiling Speakers: S86T725PG8U
      c. Wall Speakers: MB8TSQ/SL Metal Box Speakers
   3. Outdoor / Gym / Locker Room Speakers shall be Atlas Sound:
      a. Atlas Sound VTF-157UCN or similar
   4. Pendant Speaker:
      a. Tannoy OCV 6
      b. TOA PE-304
      c. TOA PJ-304

K. Master Clock
   1. The system shall match the existing clock system.
   2. The system shall provide for automatic clock correction for Daylight Savings Time, Spring Ahead/Fall Back. Daylight savings shall not require the use of any user input at the time of daylight savings.
   3. The master clock system shall support a minimum of 16 schedules and 1536 events as outlined in the Intercom/PA Features section.
   4. The system shall support Electronic Message Displays. These displays are integral to the emergency notification needs of the facility.
   5. In the event of an Emergency Call from a classroom, the origin of the Emergency Call is displayed on multiple Electronic Message Displays, giving the opportunity for school staff to respond more quickly. In addition, a console or room telephone has the ability to activate a specific message for display on a group of EMDs. This allows an emergency procedure such as school “lock down” to be activated from any telephone, quickly and efficiently.

L. Clocks
   1. Clocks shall be Sapling battery powered, wirelessly corrected clocks in 12” and 16” surface, round.
      a. All clocks shall be corrected via RF.

M. Accessories
   1. Wireless Repeater.
   2. Wire guard.

N. Corridor Clocks
   1. Double faced 12” battery powered, wirelessly corrected slave clocks where indicated

O. Cable and Jacks
   1. 50 Micron OM4 Fiber
   2. Cat 6 UTP

3. Headend to Call Switches shall be West Penn 25359B Plenum Rated Wire. Red/Black to speakers, Green/White to call switches.
4. PA Cable shall be plenum rated.
5. PA Cable shall be yellow or approved equal.
6. Hallway and exterior speaker runs shall utilize West Penn 25292B Plenum rated cable with no more than 10A per circuit.
7. PA Cable must be presented to the school district for approval prior to installation.

P. UPS

1. System shall be powered via a 2200 VAC UPS

Q. SPARE CAPACITY/SYSTEM EXPANSION

1. The contractor shall include extra circuits for staff telephones and loudspeakers built into the system for future expansion. Contractor shall provide and install fifteen percent (15%) extra circuitry (line cards, expanders, etc.) for these devices. The Owner shall add only field instruments (telephones and loudspeakers), cabling, and programming to make these extra capacity circuits fully operational.

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 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 device 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 additional intercom equipment, devices, and 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 intercom/PA/master clock system, including (but is not limited to) cable, connectors, patch panels, call switches, speakers, etc…

B. Secure all horizontal cables within ceiling cavities to building structure.

1. 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 (similar to Caddy Series "CableCat" or approved alternate mounting methods) including placement in cable tray as indicated on Drawings. All mounting clips shall be seismic type as per BOCA.
2. Do not violate manufacturer's recommended loadings. Leave 30% capacity for future use of pathway.
3. Verify all horizontal cable run lengths prior to installation. Re-distribute horizontal cabling to maintain distance requirements and maintain pathway route accessibility.
4. Do not support cables from ceiling grid T-Bars, grid wire supports or bridle rings.
5. Do not allow cables to touch ceiling grid.
6. Install cables in EMT conduit in all unfinished, exposed areas as shown in Design consultant 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 or damage.
8. Place cables in compliance with TIA/EIA-568.B standards and BICSI recommended methods.
9. 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.

C. 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.

D. Install all cable in accordance with National, state and local codes and TIA/EIA Standards, and BICSI methods.

1. Follow manufacturer's guidelines and requirements for all cable termination.
2. Follow detail drawings to locate equipment racks and cabinets. Where it is necessary to deviate, to obtain 30-inch clearance between equipment, obtain Design consultant's written approval before mounting cabinet/rack.
3. Ladder-type cable tray shall be affixed 6 inches above all data racks and equipment cabinets, and routed to all points of entry into each telecommunications room.
   a. Include transition to proper height for penetration into hallway or other wall penetration as indicated on Drawings.
   b. Install sufficient 4-inch conduits from telecom rooms into hallway (minimum of 2) with protective insulating bushings, cable spillway or specially designed cable tray sections, with appropriate firestop materials.

E. Properly terminate all cables at speakers, call switches, administrative consoles 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."

F. Permanently identify all system components following TIA/EIA-606A "Administration Standard for Commercial Telecommunications Infrastructure" with identification format:

1. Identification: Provide permanent identification labels for end devices and associated cabling at each end.

3.04 TESTING

A. Intercom and Clock

1. Upon completion of work, all parts of the system installation shall be tested by the 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-Builts

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. 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 1-Year Installers warranty has been given to a school district Technology representative.
7. Submit Manufacturers Extended Warranty Application.

END OF SECTION

SECTION 31 00 00

EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION

A. Earthwork includes: clearing, compaction, embankment, excavation, filling and grading, grubbing & stripping of topsoil.

B. The extent of earthwork is shown on the drawing.
   1. Remove shrubs, trees, grass or obstructions which interfere with new construction and are noted to be removed per drawings. Preparation of subgrade for slabs, pavements, and foundations are also included as part of this work.

1.2 QUALITY ASSURANCE

A. Codes and Standards: Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.

B. Provide soil testing and inspection service. Inspection agency selected and paid by contractor subject to approval of the Engineer.

1.3 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction: Testing agency will inspect and Engineer will approve subgrades and fill layers before further construction work is performed thereon.

B. If, based on reports of Testing Agency and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction and testing at no additional expense.

1.4 JOB CONDITIONS

A. Existing Utilities: Locate existing underground utilities in the areas of work.
   1. Should uncharged or incorrectly charged piping or other utilities be encountered during excavation, consult the Owner immediately for directions as to proceed.
   2. Contact "Miss Utility" and Owner for assistance in locating existing utilities.

B. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
   1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

1.5 RELATED WORK SPECIFIED ELSEWHERE

Erosion and Sediment Control: Section 31 25 00

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Subgrade Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, natural or crushed sand, as acceptable to the Owner.

B. Backfill and Fill Materials: Provide acceptable soil materials for backfill and fill from borrow, or onsite stockpile, free of clay, rock, or gravel larger than 1" in any dimension, debris, waste, frozen materials, organic and other deleterious matter. Material to be in accord with governing jurisdiction and specifications: Delaware Standard Specifications for Road and Bridge Construction, August 2001, and all subsequent amendments thereof. DELDOT Type B shall be used unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which excavating, filling and grading are to be performed and determine suitability of stockpiled soil for use as backfill and fill material. Do not proceed with the work until unsatisfactory conditions have been corrected and accepted by the Engineer.

B. Soil Bearing Testing
1. The Contractor shall be responsible for testing of the available soil bearing capacity. He shall arrange for such testing by an independent testing agency approved by the Engineer or Architect, the following tests shall be performed:
   a. Minimum one (1) three foot deep penetrometer test and subsequent bearing capacity evaluation per 500 S.F. of structure footprint.
2. The Contractor shall secure the necessary proctor tests and one field density test for every 50 CY of backfill material used for structures and embankments. A minimum of two field density tests per structure or embankment will be required.
3. The Engineer may request the necessary proctor tests and one compaction test per 100 L.F. section of backfilled trenches at any time during backfilling operations <u>or</u> upon completion of the backfill operations.

3.2. EXCAVATION

A. Excavation consists of removal and disposal of material encountered when establishing required grade elevations.

B. Earth excavation consists of removal and disposal of pavements and other obstructions visible on ground surface.

C. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Owner. Under footings, foundation bases or slabs fill unauthorized excavation by extending the indicated bottom elevation of the footing or base to the excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, only when acceptable to the Owner. Elsewhere, backfill and compact unauthorized excavation as specified for authorized excavations of same classification, unless otherwise directed by the Owner. Payment will not be made to the contractor for filling unauthorized excavation.

D. Stability of Excavations: Slope side of excavation to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible either because of space restrictions or stability of material excavated.
   1. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

E. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and crossbraces, in good serviceable condition.
   1. Provide minimum requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.
   2. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.

F. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
   1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
   2. Convey water removed from excavations and rain water to collecting or run-off areas. Provide and maintain temporary drainage ditches and other diversions outside excavation limits for each structure. Comply with applicable sediment control measures. Do not use trench excavations as temporary drainage ditches.
   3. 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 pipes 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.
   4. 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. Water shall be piped to the nearest point of the municipal storm drainage system as directed by the Engineer. Contractor to provide necessary traffic control to maintain temporary piping. No discharge to the sanitary sewer system shall be allowed.

5. In the event the Contractor's dewatering operations affect any water supplies within the project area, the Contractor shall take whatever steps that are required to provide uninterrupted water service.
6. 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.

G. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.
1. Locate and retain soil materials away from edge of excavations.
2. Dispose of excess and/or unsatisfactory soil material and waste materials as specified hereinafter.

H. Excavation for Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10" and extending a sufficient distance from footings and foundations to permit placing and removal of concrete form work, installation of services, other construction required, and for inspection. In excavating for footings and foundations, take care not to disturb bottom of excavation.
Excavate by hand to final grade just before concrete is placed. Trim bottoms to required lines and grades to leave solid base to receive concrete.

I. Excavation for Pavements: Cut surface under pavements to comply with cross sections, elevations and grades as shown.

J. Removal of Unsatisfactory Soil Materials: Excavate unsatisfactory soil materials encountered that extend below required elevations, to additional depth directed by the Engineer. Unsatisfactory material is defined as clay, silt, etc. which would not, in the Engineer's opinion, provide adequate strength and would not compact properly. Unsatisfactory material shall be removed from the site.

3.3 COMPACTION

A. General: Control soil compaction during construction providing minimum percentage of density specified for each area classification.
B. Percentage of Maximum Density Requirements: Provide not less than the following percentages of maximum density of soil material compacted at -2 to +2 percent of optimum moisture content, as determined by ASTM D1557, for the actual density of each layer of soil material-in-place.
1. Building Slabs and Steps: Compact top 12" of subgrade, place material in 8" loose layers and compact each layer of backfill or fill material to 95% maximum density.
2. Lawn or Unpaved Areas: Compact top 6" of subgrade, place and compact each layer of backfill or fill material to 90% maximum density.
3. Walkways: Compact top 6" of subgrade. Place material in 8" loose layers and compact each layer of backfill or fill material at 95% maximum density.
4. Pavements: Compact top 12" of subgrade, place material in 8" loose layers and compact each layer of backfill or fill material to 95% maximum density.
5. Pipeline: Backfill in 8" loose layers with mechanical compaction, to 95% maximum density in traffic areas and 90% in non-traffic areas.

6. Backfill in demolition areas: Backfill in 8" loose layers with mechanical compaction to 95% maximum density.
7. Embankments: Place material in 8" loose layers with mechanical compaction to 95% maximum density.

C. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material.

3.4 BACKFILL AND FILL

A. General: Place satisfactory excavated, borrow or stockpiled material in layers to required subgrade elevations.

B. Backfill excavations promptly as work permits, but not until completion of the following:
1. Acceptance by Engineer of construction below finish grade including, where applicable, dampproofing, and perimeter insulation.
2. Inspection, testing, approval, and recording locations of underground utilities.
3. Removal of concrete formwork.
4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials.
5. Removal of trash and debris.

C. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip or break-up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.
1. When existing ground surface has a density less than that specified under "Compaction" for the particular area classification, break up the ground surface, pulverize, moisture-condition to the optimum moisture content and compact to required depth and percentage of maximum density.

D. Placement and Compaction: Place backfill and fill materials in layers not more than 8" in loose depth. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content. Compact each layer to required percentage of maximum density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
1. Place backfill and fill materials evenly adjacent to structures, to required elevations. Take care to prevent wedging action of backfill against structures by carrying the material uniformly around structure to approximately same elevation in each lift.

3.5 GRADING

A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

B. Grading Outside Structures: Grade areas adjacent to structures to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes, and as follows:
   1. Grassed Areas: Finish areas to receive topsoil to within not more than 0.10' above or below the required subgrade elevations.
   2. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 0.10' above or below the required subgrade elevations.
   3. Pavements: Shape surface of areas under pavement to line, grade and cross-section, with finish surface not more than 0.10' above or below the required subgrade elevation.

C. Grading Surface of Fill Under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 0.2'.

D. Compaction: After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.6 MAINTENANCE

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion, and keep free of trash and debris.

   1. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

B. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.

END OF SECTION

SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.1 USE OF EXPLOSIVES

A. The use of explosives will not be permitted.

1.2 PROTECTION OF PERSONS AND PROPERTY

A. Clearing and grubbing operations shall be conducted in a manner that will ensure safety of persons and prevent damage to existing structures and utilities, construction in progress, trees, vegetation designated to remain standing including root damage, and other property.

PART 2 - PRODUCTS

2.1 FILL MATERIAL

A. Fill material needed for filling depressions shall be Delaware Department of Transportation Type B borrow material, in accordance with Section 209 or approved excavated material.

PART 3 - EXECUTION

3.1 CLEARING OPERATIONS

A. Clearing shall consist of the vegetation designated for removal, including rubbish occurring within the areas to be cleared. Clearing shall also include the complete removal and disposal of the tennis courts that obtrude, encroach upon, or otherwise obstruct the work.

3.2 GRUBBING OPERATIONS

A. The Contractor shall completely remove all debris protruding through the ground surface. This material shall be excavated and remove to a depth of not less than 12 inches below the surface level of the original ground.

3.3 FILLING DEPRESSIONS

A. Depressions resulting from grubbing operations shall be completely filled with fill material, unless further excavation or earthwork is indicated.

B. Prior to filling, subgrade surfaces of depressions shall be free of standing water, frost, or frozen material.

C. The Contractor shall place fill material in horizontal layers not to exceed 8 inches in loose depth. Each layer shall be compacted between -2 to +2 percent of the optimum moisture

content and to 90% of maximum dry density outside of paving and 95% in areas of proposed paving, as determined by ASTM D1557. The density of soil-in-place shall be determined in accordance2 with ASTM D1556, Sand Cone Method or ASTM D2922, Nuclear Method. The surface of filled depressions shall be graded to meet adjacent proposed contours and to provide surface water drainage.

3.4 DISPOSAL OF CLEARED AND GRUBBED MATERIAL

A. Burning of materials on site will not be permitted.

B. Refuse from the clearing and grubbing operations shall be removed for disposal at no additional cost to the Owner. Costs of permits and fees for disposal shall be paid by the Contractor. The Contractor shall be responsible for compliance with federal, state, and local laws and regulations pertaining to the control of environmental pollution, building of fires, and other regulated practices in the disposal of cleared and grubbed materials.

END OF SECTION

SECTION 31 11 00

CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 USE OF EXPLOSIVES

A. The use of explosives will not be permitted.

1.2 PROTECTION OF PERSONS AND PROPERTY

A. Clearing and grubbing operations shall be conducted in a manner that will ensure safety of persons and prevent damage to existing structures and utilities, construction in progress, trees, vegetation designated to remain standing including root damage, and other property.

PART 2 - PRODUCTS

2.1 FILL MATERIAL

A. Fill material needed for filling depressions shall be Delaware Department of Transportation Type B borrow material, in accordance with Section 209 or approved excavated material.

PART 3 - EXECUTION

3.1 CLEARING OPERATIONS

A. Clearing shall consist of the vegetation designated for removal, including rubbish occurring within the areas to be cleared. Clearing shall also include the complete removal and disposal of the tennis courts that obtrude, encroach upon, or otherwise obstruct the work.

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A. The Contractor shall completely remove all debris protruding through the ground surface. This material shall be excavated and remove to a depth of not less than 12 inches below the surface level of the original ground.

3.3 FILLING DEPRESSIONS

A. Depressions resulting from grubbing operations shall be completely filled with fill material, unless further excavation or earthwork is indicated.

B. Prior to filling, subgrade surfaces of depressions shall be free of standing water, frost, or frozen material.

C. The Contractor shall place fill material in horizontal layers not to exceed 8 inches in loose depth. Each layer shall be compacted between -2 to +2 percent of the optimum moisture

content and to 90% of maximum dry density outside of paving and 95% in areas of proposed paving, as determined by ASTM D1557. The density of soil-in-place shall be determined in accordance with ASTM D1556, Sand Cone Method or ASTM D2922, Nuclear Method. The surface of filled depressions shall be graded to meet adjacent proposed contours and to provide surface water drainage.

3.4 DISPOSAL OF CLEARED AND GRUBBED MATERIAL

A. Burning of materials on site will not be permitted.

B. Refuse from the clearing and grubbing operations shall be removed for disposal at no additional cost to the Owner. Costs of permits and fees for disposal shall be paid by the Contractor. The Contractor shall be responsible for compliance with federal, state, and local laws and regulations pertaining to the control of environmental pollution, building of fires, and other regulated practices in the disposal of cleared and grubbed materials.

END OF SECTION

SECTION 31 23 00

EXCAVATION AND BACKFILL FOR PIPELINES AND STRUCTURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. The Contractor shall perform all excavation, backfilling grubbing and grading required for construction and installation of pipelines, structures and appurtenances. 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, 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, 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. 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, whether such facility is or is not shown on the drawings.

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 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 in the proposal.

D. Excavation and backfill, within an area where a State agency has jurisdiction, shall be done in accordance with requirements and provisions of the permits issued by the agencies for the construction within their respective rights-of-way. Such requirements and provisions, where applicable, shall take precedence and supersede the provisions of these specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

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.

PART 3 - EXECUTION

3.1 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 or 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 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, etc., and required for safety. Safety regulations shall be as required by State safety codes and OSHA.

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 and straight 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., Contractor shall replace such paving at his own expense. Saw cuts shall be carried out to the full depth of existing bituminous or concrete paving or combination thereof.

E. In non-paved areas strip surface vegetation and 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 or the Town Inspector. 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 Town 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 Subgrade" 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, repaving 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, change or protect all structures including but not limited to signs, mailboxes, overhead and buried utilities 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 not shown on plans.

L. The Contractor shall be responsible for any damage to curb, gutter, sidewalk, traffic control devices, pavement material 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 control joint. Cost for replacement shall be included in the linear foot cost for pipe.

3.2 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 8-inch layers. Compaction shall be accomplished by mechanical tampers. 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 optimum moisture content as determined by the Modified Proctor Test, ASTM D1557 Method C. 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 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 Engineer may request compaction tests of the backfilled trenches at any time during construction or upon completion of the backfill operations. As a minimum field density testing shall be performed at a rate of 1 test per 100 linear feet of trench, at a depth and location specified by the Engineer or his representative. Such testing shall be arranged by the Contractor 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. The Contractor will be paid, at the unit price bid, for all Proctor tests. For those field density tests which indicate that compaction satisfies specification requirements, the Contractor will be paid for testing at the unit price bid. For those tests which indicate that compaction does not satisfy specification requirements, the Contractor will not be paid. Whenever test results indicate compaction densities less than specified, the Contractor shall, at his own expense, secure the specified compaction using 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, street and depth, as a minimum.

F. 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.

G. 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.

H. 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.

I. 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.

3.3 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.

B. Excavated materials shall be segregated as they are excavated, with the suitable and unsuitable material and topsoil being piled separately. All suitable material shall be used for backfill. All unsuitable material shall be removed, at the Contractor's expense, and disposed of at a approved off-site location. 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.

C. The Contractor shall be responsible for the condition of all excavations made by him. All slides and cave-ins shall be removed without extra compensation, at whatever time and under whatever circumstances they may occur.

3.4 BACKFILL FOR STRUCTURES

A. Backfill around structures with suitable material from the excavation to the original surface grades or the finished grades shown on the plans or defined by the Engineer. If additional material is needed to fill around the structure, Special Backfill shall be furnished and placed by the Contractor at the price bid in the proposal.

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. Compaction shall conform with 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.

3.5 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 but will be paid for as "Miscellaneous Excavation and Backfill".

B. Miscellaneous Excavation shall include the digging of test pits in the areas not called out on the project plans, extra width of trench made necessary by change in its location, 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 or as necessary to determine location, depth or materials of existing utilities. The depth and size shall be such as required by the Engineer. Test pits shall be dug by the Contractor, without being directed to do so, 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.

3.6 EXCAVATION BELOW SUBGRADE AND GRAVEL REFILL

A. Materials below the excavation limit for pipelines and structures (below subgrade), 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 subgrade shall be refilled and compacted with crushed stone or gravel. Payment for Excavation Below Subgrade and Gravel Refill shall be made at the unit price bid.

B. Should the Contractor elect to excavate suitable material below subgrade 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 Subgrade and Gravel Refill.

3.7 DEWATERING

A. All excavations must be kept free of water below the subgrade 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. 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 are 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.

3.8 SHEETING, SHORING AND BRACING

A. The Contractor shall furnish and install all sheeting, shoring and bracing necessary to insure safe working conditions and to prevent damage to public and private property and structures. If, in the opinion of the Engineer, the sheeting, shoring, or bracing is not of proper quality or is not properly placed to insure safe working conditions and to prevent property damage, the Contractor shall remedy such inadequacy at his own expense as may be directed by the Engineer. Sheeting, shoring, and bracing shall be removed as backfilling progresses, except at such locations as the Engineer may direct or approve it to be left in place.

B. 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.

C. 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.

D. 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.

E. The cost for furnishing, placing and removal of sheeting, shoring or bracing shall be included in the prices bid.

F. A trench box is an acceptable alternative to sheeting, shoring or bracing providing such boxes conform to safety codes.

3.9 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 prices bid for pipe and structures.

B. Should sufficient suitable material from excavations on the project not be available for backfill, the Contractor shall furnish Select Backfill upon approval of the Engineer. Special backfill shall conform to Delaware DOT. Type G.

C. Payment for authorized Select backfill will be made at the price bid for the material placed within the trench width detailed and for the length and depth approved.

3.10 GRAVEL BEDDING

Gravel bedding for installation of under structures shall meet the requirements of #57 stone per Section 813 of the Delaware Standard Specifications.

END OF SECTION

SECTION 31 25 00

EROSION & SEDIMENT CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

Provide necessary equipment, labor and supplies for erosion and sediment control throughout project. Work consists of grading of site, providing silt fence, inlet protection, and straw bale dikes and other necessary measures required for effective control. Sediment and erosion control work shall comply with the requirements of the State of Delaware Erosion and Sediment Control Handbook, 2005 Addition, and the Delaware Sediment and Stormwater Regulations, issued January 2014. The receipt of a proposal by a bona fide bidder shall be interpreted to mean the Contractor has familiarized himself with these Regulations and Rules of Procedure and is fully cognizant of exactly what is required.

1.2 SUBMITTALS

A. Erosion and Sediment Control Schedule.

At pre-construction conference or prior to start of actual construction, submit for acceptance, schedules for accomplishment of temporary and permanent erosion control work. Submit schedule for each of the following procedures: Grading, construction and paving. No work shall be started until erosion control schedules and methods of operation have been approved.

1.3 EXECUTION

A. Throughout the duration of the project, control erosion and minimize siltation to rivers, streams and impoundments. Control shall include, but is not limited to the use of berms, dikes, dams, sediment basins, sediment traps, filters, fiber mats, netting, gravel or crushed stone, mulch, grasses, slope drains, and other methods. Erosion and sediment control measures as described herein, and on the drawings, shall be applied to erodible materials exposed by any project activity.

B. Coordinate erosion and sediment control measures with the construction of the permanent drainage facilities which shall be constructed prior to the grading operation to assure economical, effective and continuous erosion and siltation control.

C. Dress, prepare, and seed slopes immediately following the completion of each portion of work and immediately following suspension of grading operations.

D. Fill slopes shall be dressed, prepared and seeded as the embankment proceeds to the extent needed to stop erosion and sedimentation.

E. The Contractor shall incorporate permanent erosion control features into the project at the earliest practicable time. Temporary erosion control measures shall be used to correct conditions that develop during construction that were not foreseen during the design

stage, that are needed prior to installation of permanent erosion control features, or that are needed temporarily to control erosion that develops during normal construction practices that are not associated with permanent control features of the project.

END OF SECTION

SECTION 31 31 16

TERMITE CONTROL

PART 1 - GENERAL

1.01 SUMMARY

A. Provide soil treatment for termite control.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Warranty: Submit manufacturer's standard warranty. Include labor and materials to repair or replace defective materials.

1. Warranty Period: 5 years.

1.03 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Soil Treatment Materials: Soil treatment materials shall bear Federal registration number of U.S. Environmental Protection Agency and acceptable to authorities having jurisdiction. If acceptable, products may include chloropyrifos, permathrin, cypermethrine, fenvalerate, isofenphose.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Treat soil in strict compliance with National Pest Control Association standards and with manufacturer's printed instructions and recommendations.

B. Treat areas under floor slabs prior to placement of concrete if possible to avoid drilling. Treat areas outside foundation walls after excavation, filling and grading are complete. Do not apply treatment to frozen or excessively wet soils.

C. Post signs and other warnings indicating that soil poisoning has been applied. Protect persons and property from injury or damage from soil treatment work.

END OF SECTION

SECTION 31 32 00

SOIL STABILIZATION

PART 1 - GENERAL

1.1 Includes topsoil, fertilizers and lime for unpaved disturbed areas as shown on the Drawing.

1.2 SUBGRADE

A. To be neutralized with lime if highly acid or composed of heavy clay.

1.3 SUBMITTALS

A. Laboratory test results of topsoil for PH, soluble salts and application requirements for lime and fertilizer.

1.4 Related work specified elsewhere: Turf and Grass 32 92 00.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. Sandy loam, silt loam, or other soil approved by the Owner.

B. Shall not contain subsoil, slag, cinders, stones, lumps of soil, sticks, roots, trash or other extraneous materials larger than 1" in diameter or length.

C. Must be free of plants or plant parts of bermuda grass, quackgrass, Johnson grass, nutsedge, poison ivy, Canadian thistle, or others as specified.

D. A pH of 5.0 to 7.0 is required.

E. Soluble salts shall not be higher than 500 parts per million.

2.2 FERTILIZERS

A. Uniform in composition, free flowing and suitable for application with approved equipment.

B. Delivered to the site fully labeled according to applicable State Fertilizer Laws and shall bear the name, trade name or trade-mark and warranty of the producer.

C. Fertilizer application rates shall be determined by soil tests per the approved sediment & erosion control plan.

D. Fertilizer shall be distributed evenly over the area to be seeded.

2.3 LIME

A. Shall be ground limestone (hydrated or burnt lime may be substituted) which contains at least 50% total oxides (calcium oxide plus magnesium oxide).

B. Ground limestone shall be ground to such fineness that at least 50% will pass through a 100-mesh sieve and 98 to 100% will pass through a 20-mesh sieve.

C. Application rates of liming materials shall be per the approved sediment & erosion control plan.

D. Lime shall be distributed uniformly over the entire areas to be seeded.

PART 3 - EXECUTION

3.1 SUBSOIL

A. Test for PH. If highly acid apply ground limestone at the rate of 100 pounds per 1,000 sq. ft.

B. Immediately prior to placing topsoil, loosen subsoil by disking or scarifying to a depth of at least two inches.

3.2 TOPSOIL

A. Topsoil shall be uniformly distributed on the designated areas and it shall be a minimum depth of 4 inches after firming.

B. Spreading shall be performed in such a manner that seeding can proceed with a minimum of additional soil preparation and tillage.

C. Any irregularities in the surface resulting from topsoiling or other operations shall be corrected in order to prevent the formation of depressions or water pockets.

D. Topsoil shall not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or in a condition that may otherwise be detrimental to proper grading or proposed seeding.

E. After the topsoiling has been spread and the final grades approved, it shall be cleared of all grade stakes, surface trash and other objects that would hinder maintenance of seeded and planted areas.

F. Paved areas over which hauling operations are conducted shall be kept clean, and any soil which may be brought upon the surfacing shall be promptly removed.

G. The wheels of all vehicles shall be kept clean to avoid tracking soil on the surfacing of roads, walks or other paved areas.

H. Lime and fertilizer shall be uniformly mixed into the top 4 inches of soil by disking, harrowing or other approved methods.

I. Any undulations or irregularities in the surface resulting from fertilizing, liming, tilling or other causes shall be leveled prior to seeding.

J. Flooded, washed out or areas otherwise damaged shall be reconstructed and all grades re-established by the landscape contractor in accordance with the drawings and/or other applicable specifications.

END OF SECTION

SECTION 31 50 00

EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Provide shoring and bracing for sidewalls in deep excavations with steel sheet, soldier piles or timber lagging to protect existing buildings, utilities, roadways, and improvements.

1.02 SUBMITTALS

A. Shop Drawings: Layout of shoring and bracing and other data, acceptable to local authorities having jurisdiction, prepared by a qualified professional engineer.

1.03 QUALITY ASSURANCE

A. Survey of Adjacent Structures and Levels: Registered land surveyor prior to excavation.

B. Engineer: A professional engineer licensed in the jurisdiction of the project.

C. System Design: Prevent cave-ins, loss of ground, or damage to people and property. Maintain shoring and bracing during construction activities, and remove shoring and bracing if practical when construction and filling is complete.

D. Comply with codes and ordinances of governing authorities having jurisdiction. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Sheet steel: Heavy-gauge steel sheet suitable for service.

B. Soldier piles: Steel H-beams in serviceable condition.

C. Timber lagging: Heavy timber pressure treated with wood preservative.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in proper relation with adjacent construction to permit forming and finishing of concrete surfaces. Coordinate with work of other sections.

B. Locate shoring and bracing to avoid permanent construction. Anchor and brace to prevent collapse.

END OF SECTION

SECTION 32 11 26

BITUMINOUS STABILIZED BASE COURSES

PART 1 - GENERAL

1.01 SUMMARY

A. Provide hot-mixed asphalt paving over prepared subbase and roadway markings.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Test Reports: Submit for approval test reports.

1.03 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

B. Construction Tolerances:

1. Surface Course Thickness: Within 1/4 inch.
2. Base Course Surface Smoothness: Within 1/4 inch.
3. Surface Course Surface Smoothness: Within 3/16 inch. No ponding acceptable.
4. Crowned Surfaces: Within 1/4 inch from template.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Asphalt-Aggregate Mixture: Plant-mixed, hot-laid asphalt-aggregate mixture, ASTM D 3515, complying with local DOT and DPW regulations.

B. Prime Coat: Cut-back asphalt, ASTM D 2027.

C. Tack Coat: Emulsified asphalt, ASTM D 977.

D. Herbicide Treatment: Commercial chemical for weed control registered by Environmental Protection Agency and acceptable to authorities having jurisdiction.

E. Lane and Parking Area Marking Paint, Yellow Color: Alkyd-resin type, ready-mixed, AASHTO M 248, Type I.

F. Lane and Parking Area Marking Paint, White Color: Alkyd-resin type, ready-mixed, AASHTO M 248, Type I.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Asphalt/Aggregate Mixture: Comply with local DOT or DPW Standard Specifications for Highways and Bridges. Class as required by loading and use.

B. Remove loose material from compacted subbase. Proof roll and check for areas requiring additional compaction. Report unsatisfactory conditions in writing. Beginning of work means acceptance of subbase.

C. Apply prime coat to prepared subbase. Apply tack coat to previous laid work and adjacent in-place concrete surfaces.

D. Place asphalt concrete at minimum temperature of 225 degrees F in strips not less than 10' wide overlapping previous strips. Complete entire base course before beginning surface course.

E. Construct curbs to dimensions indicated or if not indicated to standard shapes. Provide tack coat between curb and pavement.

F. Begin rolling when pavement can withstand weight of roller. Roll while still hot to obtain maximum density and to eliminate roller marks.

G. Provide 4" lane and striping paint in uniform, straight lines. Provide wheel stops where indicated and securely dowel into pavement. Protect work from traffic and damage.

H. Test in-place asphalt work for thickness and smoothness. Remove and replace defective work and patch to eliminate evidence of patching

END OF SECTION

SECTION 32 11 36

CONCRETE BASE COURSES

PART 1 - GENERAL

1.01 SUMMARY

A. Provide cast-in-place concrete paving over prepared subbase.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Design Mixes: Submit for approval design mixes, including adjustments for variations in project conditions.

C. Test Reports: Submit for approval test reports.

1.03 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

B. Construction Tolerance: 1/8" in 10' for grade and alignment of top of forms; 1/4" in 10' for vertical face on longitudinal axis.

C. Testing: Independent testing laboratory.

D. Mock-Ups: Provide mock-up as required to demonstrate quality of workmanship.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Concrete: ASTM C 150, Type I, Portland cement; ASTM C 33, normal weight aggregates; potable water.

1. Design Mix: ASTM C 94, 3000 psi, 28-day minimum compressive strength.
2. Slump Limits: 8 inches minimum with superplasticizer, 3 inches otherwise.
3. Air Content: 5 to 8 percent.
4. Finish: Broom finish, perpendicular to direction of travel.

B. Wire Mesh Reinforcement: Welded plain steel wire fabric, ASTM A 185.

C. Reinforcing Bars: Deformed steel bars, ASTM A 615, Grade 60.

D. Fabricated Bar Mats: Steel bar or rod mats, ASTM A 184, using ASTM A 615, Grade 60 steel bars.

E. Joint Dowel Bars: Plain steel bars, ASTM A 615, Grade 60.

F. Hook Bolts: ASTM A 307, Grade A threaded bolts.

G. Liquid-Membrane Forming and Sealing Curing Compound: ASTM C 309, Type I, Class A.

H. Bonding Compound: Polyvinyl acetate or acrylic base.

I. Epoxy Adhesive: ASTM C 881.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Proof roll subbase and check for unstable areas. Report unsatisfactory conditions in writing. Beginning paving work means acceptance of subbase.

B. Comply with concrete section for concrete mix, testing placement, joints, tolerances, curing, repairs and protection.

C. Dispose of over-mixed concrete off-site in a legal manner.

D. Protect concrete paving until weight of a person will not leave any impression. Remove and replace concrete paving which shows impressions or other defects. Skim coating defects is not acceptable.

END OF SECTION

SECTION 32 12 16

ASPHALT PAVING

PART 1 - GENERAL

1.1 DESCRIPTION

A. The Contractor shall restore all surfaces damaged by his operations and install all new asphalt paving to the width and extent detailed, noted on the plans or specified herein.

B. Surface restoration in streets and roads maintained by the State Department of Highways shall be accomplished in accordance with applicable utility construction permits.

PART 2 - EXECUTION

2.1 GENERAL

A. Various conditions and types of surface restoration are shown on the drawings. Materials and construction methods to be in accordance with the following specification and the Delaware DOT Standard Specifications dated July 1985.

B. Existing pavement not subject to complete repavement shall be trimmed to secure a straight clean edge for repaving. Saw cut bituminous pavement as shown on the drawings and as directed to obtain a clean pavement edge.

C. No staggered or irregular longitudinal trench repair widths shall be allowed in each block of work. Repairs shall be of a uniform width and in a straight line.

D. Minimum pavement restoration width is five (5) feet including edge of roads. Actual width shall be as detailed or noted on the plans. Should the Contractor damage or disturb larger areas, he shall replace the additional area at his cost.

E. Undermined areas shall be grout filled or cut back.

F. A 2" inch layer of cold patch shall be placed on all lateral and main utility trenches for temporary paving at the end of every workday.

G. Catch basins, inlets, curbs and all other appurtenances shall be adequately covered and protected prior to application of bituminous materials. No earth or bituminous materials shall be allowed to enter any storm drainage system and suitable containment provisions shall be employed to prevent surface runoff of bituminous materials.

H. Unless otherwise noted the final surface shall match grades existing prior to construction and shall be such that a smooth transition free of abrupt changes in grade is made with adjacent pavements and/or sidewalks. No depressions or other misalignment shall obstruct, trap or otherwise misdirect the flow of surface water drainage.

2.2 MAINTENANCE OF REFILLED EXCAVATIONS

A. The Contractor shall maintain, at his own expense, all refilled excavations and surfacing in proper condition as specified herein. All depressions appearing in the refilled excavation, stabilized base and temporary paving shall be properly refilled. If the Contractor fails to make repairs within 48 hours after receipt of written notice from the Engineer, the Owner may refill said depressions and the cost thereof shall be deducted from any monies due the Contractor. In case of emergency the Owner may refill any depressions to protect with barricades without giving previous notice to the Contractor, and the cost of so doing shall be retained from any monies due or to become due the Contractor.

B. The Contractor shall be responsible for any injury or damage that may result from lack of maintenance of any refilled excavation at any time.

2.3 CRUSHER RUN BASE COURSE

A. Crusher run base course (Type "B") shall be spread on prepared and compacted refilled excavations to the compacted depth shown on the drawing details.

B. Materials and methods of construction shall meet the provisions of Section 821 of referenced standard specification.

2.4 BITUMINOUS CONCRETE PAVEMENT

A. Hot mix, hot laid bituminous concrete shall consist of placing bituminous concrete base and or wearing courses on a prepared base to the minimum compacted thickness shown on the drawings.

B. The hot-mix bituminous concrete surface and base courses shall conform to the Delaware DOT Standard Specifications for Type C & B, respectively and shall be constructed in accordance with the applicable Articles of Section 401 "Hot-Mix, Hot Laid Bituminous Concrete Pavement".

C. The subgrade shall be properly prepared, graded and compacted in accordance with Section 02200 of these specifications.

D. Materials and methods of construction shall meet the provisions of Section 401 of referenced standard specification. All thicknesses detailed shall be compacted thicknesses.

E. Cold mix temporary roadway material shall be furnished and placed as shown on the drawings and or directed by the Engineer. Cold mix shall meet the provisions of Section 402 of referenced standard specification. Separate payment shall not be made for temporary paving. The cost therefore shall be included in the price bid for pipe and fittings.

2.5 BITUMINOUS CONCRETE DRIVEWAY AND PARKING AREAS

Bituminous driveways and parking areas disturbed through the Contractor's construction operations shall be restored by means of 3-inches of hot-mix bituminous concrete pavement placed in a single lift onto a base course consisting of 4-inches of properly prepared and compacted crushed stone or

quarry waste. Commercial and residential entrances on State maintained streets shall be in accordance with the plan details.

2.6 CONCRETE CURBS, SIDEWALKS AND DRIVEWAYS

A. General

1. The Contractor shall permanently repair or relay all curbs, sidewalks and driveways that have been removed, broken, or otherwise injured in executing any of the work under the contract or injured by settlement of any backfilled excavation at any time prior to termination of the contract and guarantee period.

2. Curb and sidewalk removed or damaged during construction shall be replaced in accordance with State of Delaware Department of Transportation standards. Install wheelchair curb ramps at all street corners reconstructed.

3. All concrete shall be according to Section 03 30 00 of this Specification.

4. Separate payment for reconstruction of curbs, sidewalks and concrete driveways damaged by the Contractor will not be made. However, cost shall be included within the appropriate unit and/or lump sum prices bid for furnishing and laying pipe and appurtenances.

B. Curbs

1. Concrete curbs, normal and depressed, and curb and gutter shall be replaced in accordance with Delaware D.O.T. Standard Specifications Section 701, 702 and 704 and as detailed on the drawings.

2. Curbs shall be depressed at all existing driveway locations in accordance with Delaware State Standard Details, including proper preparation of subgrade and proper placing and spacing of joints and joint materials.

3. Partial replacement, when so directed, shall extend to the nearest existing joint in each direction.

C. Sidewalks

1. Concrete sidewalks shall be replaced as required, or as directed, in accordance with Section 705 of the Delaware D.O.T. Standard Specifications. Handicapped ramps shall be installed in all areas defined herein.

2. Sidewalks in areas not subject to vehicular loading shall have a minimum thickness of 4 inches placed upon a properly prepared, graded and compacted subgrade.

3. Sidewalks in vehicular loading areas shall be a minimum thickness of 6 inches reinforced with 6-inch by 6-inch wire mesh of 10-10 gauge. Subgrade shall be prepared as stated on the project plans.

4. Replacement of partial sections of concrete sidewalk, where so directed, shall be extended to the nearest existing joint in each direction.

5. Sidewalks shall be replaced to a width equal to that existing prior to start of construction and such width shall be maintained throughout the entire length of the block. In no instance shall the constructed width be less than 4 feet.

6. A broom finish shall be applied perpendicular to the direction of traffic.

2.7 FIELD QUALITY CONTROL

A. General: Test in-place bituminous concrete courses for compliance with requirements for thickness and surface smoothness. Repair or remove and replace unacceptable paving as directed by the Owner.

B. Thickness: In-place compacted thickness will not be acceptable if exceeding following allowable variation from required thicknesses:

1. Binder Course: 1/2" plus or minus.
2. Surface Course: 1/4" plus or minus.

C. Surface Smoothness: Test finish surface of each asphalt concrete course for smoothness, using 10' straightedge applied parallel with, and at right angles to centerline of paved area. Surfaces will not be acceptable if exceeding the following tolerances for smoothness:

1. Base Course Surface: 1/4".
2. Wearing Course Surfaces: 3/16".

2.8 PARKING AND LANE MARKERS

A. All pavement markings, temporary and permanent, shall be installed in accordance with Section 748 of the Delaware Standard Specifications, Latest Edition.

B. Apply paint with mechanical equipment to produce uniform straight edges.

C. All markings destroyed during construction operations to be replaced in kind.

END OF SECTION

SECTION 32 13 12
SITE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes exterior concrete pavement for the following:
   1. Walkways
   2. Flush Curbs & Bands
   3. Stamped Colored Concrete
      a. Brick Circle - **Base Bid**
      b. Rectangular Field - **Base Bid**

B. Related Sections include the following:
   1. Division 32 "Concrete Paving Joint Sealants" for joint sealants within concrete pavement and at isolation joints of concrete pavement with adjacent construction.

1.3 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixes: For each concrete pavement mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

C. Samples: 10-lb (4.5-kg) sample of exposed aggregate.

D. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

E. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

   1. Cementitious materials and aggregates.
   2. Steel reinforcement and reinforcement accessories.
   3. Admixtures.
   4. Coloring materials
   5. Curing compounds.
   6. Applied finish materials.
   7. Bonding agent or adhesive.
   8. Joint fillers.

F. Minutes of pre-installation conference.

G. The contractor shall furnish a 3’ x 3’ sample panel for approval by the Owner’s Representative prior to construction of the designated areas. This panel shall be made from samples of the specified material using the methods and workmanship proposed for the project. Source, type, color, and range of gradation of the select seeding aggregates shall be submitted to the Owner’s Representative prior to construction of the sample panel. The approved panel shall constitute an example of minimum workmanship for all work specified under the section. If the sample panel is disapproved, additional sample panels shall be made until approval is obtained. The approved sample panels shall be kept at the job site for comparison with the finished work.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed pavement work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

1. Manufacturer must be certified according to the National Ready Mix Concrete Association's Plant Certification Program.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.

E. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by the requirements of the Contract Documents.

F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixes.

G. Mockups: Cast mockups of full-size sections of concrete pavement to demonstrate typical joints, surface finish, texture, color, and standard of workmanship.

1. Build 8 feet by 8 feet mockups in the location as directed by Landscape Architect.
2. Notify Landscape Architect seven days in advance of dates and times when mockups will be constructed.
3. Obtain Landscape Architect's approval of mockups before starting construction.
4. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.
5. Demolish and remove approved mockups from the site when directed by Landscape Architect.

H. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."

1. Before submitting design mixes, review concrete pavement mix design and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with concrete pavement to attend, including the following:

    a. Contractor's superintendent.
    b. Independent testing agency responsible for concrete design mixes.
    c. Ready-mix concrete producer.
    d. Concrete subcontractor.

1.5 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Storage of Materials: follow Division One requirements.

C. Underground Utilities: Do not proceed with concrete construction until underground construction is complete.

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, exposed surfaces.

1. Use flexible or curved forms for curves of a radius 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Deformed-Steel Welded Wire Fabric: ASTM A 497, flat sheet.

B. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A coated, plain steel.

C. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 , plain steel bars.

D. Tie Bars: ASTM A 615/A 615M, Grade 60 , deformed.

E. Hook Bolts: ASTM A 307, Grade A , internally and externally threaded. Design hook-bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:
   1. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer coated wire bar supports.

G. Epoxy Repair Coating: Liquid two-part epoxy repair coating, compatible with epoxy coating on reinforcement.

2.3 CONCRETE MATERIALS

A. General: Use the same brand and type of cementitious material from the same manufacturer throughout the Project.

B. Portland Cement: ASTM C 150, Type I.

C. Aggregate: ASTM C 33, uniformly graded, from a single source, with coarse aggregate as follows:
   1. Class: 4M.
   2. Maximum Aggregate Size: 1 inch nominal.

D. Water: ASTM C 94.

2.4 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures. Do not use admixtures containing calcium chloride.

B. Air-Entraining Admixture: ASTM C 260.

C. Water-Reducing Admixture: ASTM C 494, Type A.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

2.6 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1752, cork or self-expanding cork.

B. Coloring Agent: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
   1. Color : As selected by Landscape Architect from manufacturer's full range.

C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements, and as follows:
   1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Colored-Powder Release Agent: Factory-packaged dry combination of surface conditioning and dispersing agents interground with coloring pigments that facilitates release of stamp mats. Use coloring pigments that are finely ground, nonfading mineral oxides interground with cement.
   1. Color: Selected by Landscape Architect from manufacturer's full range.
   2. Manufacturer :
      a. Davis Colors, (800)-638-4444
      b. Scofield, (800)-800-9900
      c. Solomon Colors

F. Clear Acrylic Sealer: Manufacturer's standard waterborne, membrane-forming, medium-gloss, acrylic copolymer emulsion solution containing not less than 15 percent solids by volume; non-yellowing and UV resistant.

2.7 CONCRETE MIXES

A. Prepare design mixes, proportioned according to ACI 211.1 and ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the trial batch method.

   1. Do not use Owner's field quality-control testing agency as the independent testing agency.

C. Proportion mixes to provide concrete with the following properties:

   1. Compressive Strength (28 Days): 4000 psi .
   2. Maximum Water-Cementitious Materials Ratio: 0.50.
   3. Slump Limit: 4 inches .
   4. Minimum cement content : 520 lb / cy

D. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.

E. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows within a tolerance of plus or minus 1.0 percent:
   1. Air Content: 6.0 percent for 3/4-inch maximum aggregate.

F. Coloring Agent: Add coloring agent to mix according to manufacturer's written instructions.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94 and ASTM C 1116.

   1. When air temperature is between 85 deg F and 90 deg F , reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F , reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 PREPARATION

A. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Proceed with pavement only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

B. Remove loose material from compacted subbase surface immediately before placing concrete.

C. Aggregate Preparation -Prior to the concrete placing operation, all select exposed aggregate shall be washed thoroughly so that it is free of all dust, dirt, and clay particles. The aggregate shall be in a damp condition but without free surface water at the time of mixing. There shall be sufficient select exposed aggregate on hand to complete the topping course once it has started.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement 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.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for placing and supporting reinforcement.

   1. Apply epoxy repair coating to uncoated or damaged surfaces of epoxy-coated reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire fabric 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.

3.4 JOINTS

A. General: Construct construction, isolation, and contraction joints and tool edgings 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 pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour, unless pavement terminates at isolation joints.
1. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
2. Provide tie bars at sides of pavement strips where indicated.
3. Use epoxy bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Isolation Joints (Expansion joints): Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 20 feet max., unless otherwise indicated.
2. Terminate joint filler less than 1/2 inch from top finished surface
3. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
4. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Install precoated dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

E. Contraction Joints(Control Joints): Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to the following radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.

a. Depth : as shown on drawings

F. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to the following radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

1. Radius: 1/4 inch

3.5 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

D. Comply with requirements and with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery, at Project site, or during placement.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

H. Screed pavement surfaces with a straightedge and strike off. Commence initial floating using bull floats or darbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading dry-shake surface treatments.

I. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

J. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.

K. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, reinforcement steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.
4. Do not place concrete in case of rain.

3.6 CONCRETE FINISHING

A. General: Wetting of concrete surfaces during screeding, initial floating, or finishing operations is prohibited.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots, and fill low spots. Refloat surface immediately to uniform granular texture.
1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.7 CONCRETE PROTECTION, CURING, AND SEALING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and follow recommendations in ACI 305R for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

E. Sealer: Apply uniformly in two coats in continuous operations according to manufacturer's written instructions. Allow first coat to dry before applying second coat.

1. Begin sealing dry surface no sooner than 14 days after concrete placement.

3.8 PAVEMENT TOLERANCES

A. Sealer: Apply uniformly in two coats in continuous operations according to manufacturer's written instructions. Allow first coat to dry before applying second coat.

3.9 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/4 inch.
4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
8. Joint Spacing: as shown on drawing.
9. Contraction Joint Depth: Plus 3/8 inch, no minus.
10. Joint Width: Plus 3/8 inch no minus.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article.

B. Testing Services: Testing shall be performed according to the following requirements:

1. Sampling Fresh Concrete: Representative samples of fresh concrete shall be obtained according to ASTM C 172, except modified for slump to comply with ASTM C 94.
2. Slump: ASTM C 143; one test at point of placement for each compressive-strength test, but not less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.
3. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test, but not less than one test for each day's pour of each type of air-entrained concrete.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
5. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test, unless otherwise indicated. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.
6. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. yd., but less than 25 cu. yd. , plus one set for each additional 50 cu. yd.. One specimen shall be tested at 7 days and two specimens at 28 days; one specimen shall be retained in reserve for later testing if required.
7. When frequency of testing will provide fewer than five compressive-strength tests for a given class of concrete, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
8. When total quantity of a given class of concrete is less than 50 cu. yd., Landscape Architect may waive compressive-strength testing if adequate evidence of satisfactory strength is provided.
9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, current operations shall be evaluated and corrective procedures shall be provided for protecting and curing in-place concrete.
10. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive compressive-strength test results equal or exceed specified compressive strength and no individual compressive-strength test result falls below specified compressive strength by more than 500 psi .

C. Test results shall be reported in writing to Landscape Architect, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in pavement, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Landscape Architect but will not be used as the sole basis for approval or rejection.

E. Additional Tests: Testing agency shall make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Landscape Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

3.11 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.

B. Drill test cores where directed by Landscape Architect when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with Portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 32 13 13

CONCRETE PAVING (SIDEWALKS)

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work consists of construction of all concrete walks. Complete in place including sub-grade preparation, forms, reinforcements, finishing, curbing, etc., in strict accordance with the Drawings and as specified herein.

B. Related work not included in this section includes Section 31 00 00 - Earthwork.

PART 2 - PRODUCTS

2.1 SUB-GRADE PREPARATION

A. The sub-grade shall have a uniform compaction density throughout its entire depth and width and shall be approved by the Engineer prior to pouring any concrete.

2.2 FORMS

A. The contractor shall furnish forms that result in completely aligned concrete. Forms shall be fitted tightly and securely braced to maintain proper grade and alignment. Forms shall be cleaned and oiled with a non-staining lubricant immediately prior to placing concrete.

B. Forms shall not be removed until concrete has properly set.

2.3 MATERIALS, MIX

A. All materials (including cement, aggregate, reinforcing, joint filler and seal, curing materials, etc.) shall comply with the applicable provisions of the Standard Specifications of the governing jurisdiction: Delaware Standard Specifications for Road & Bridge Construction, July 1985, Delaware DOT and all subsequent amendments.

B. All concrete for walks, curbs, steps, etc., shall be 3000 psi at the end of 28 days. All concrete shall be in accordance with DELDOT Specifications Section 812, Class B.

2.4 JOINTS

A. Expansion joints shall be placed where slabs meet walls, steps or other rigid objects, and at approximately 20' intervals in walks. Joints shall be straight and true, perpendicular to the surface. Both edges of the joints shall be tooled to a 1/4" radius. Particular care shall be exercised to keep the surface of concrete in exactly the same plane on both sides of the joint.

B. Expansion joints shall be filled with an approved non-extruding preformed filler, 1/2" thick. Expansion filler shall extend the full depth and width of the concrete, flush with the surface and 1/2" below top surface.

C. Seal - A hot poured rubber type compound shall be used. Seal shall be flush with concrete surface and shall not extend more than 1/4" beyond each edge of joint.

D. Contraction joints shall be similar to expansion joints, except that preformed filler will be omitted and joints need not be more than 2" deep, nor less than 1/4" in section thickness. Joints shall be at 5' intervals or as shown on scoring details on the drawings.

E. Edging - all exposed edges shall be straight and true and unless otherwise shown shall be tooled to a smooth 1/4" radius.

2.5 WALKS

A. Walks shall be 4" thick in areas not subject to vehicular loading, and 6" in traffic areas. It shall be reinforced with 6" wire mesh of 10-10 gauge troweled a true and even surface, and finished with a broom finish perpendicular to the direction of traffic.

PART 3 - EXECUTION

3.1 METHODS OF CONSTRUCTION

A. Methods of construction shall conform with Section 705 of the DELDOT Specifications.

END OF SECTION

SECTION 32 13 73
CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes joint sealants for exterior pavement joints.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that have been produced and installed to establish and to maintain watertight and airtight continuous seals without causing staining or deterioration of joint substrates.

1.4 SUBMITTALS

A. Product data from manufacturers for each joint sealant product required.

1. Certification by joint sealant manufacturer that sealants plus the primers and cleaners required for sealant installation comply with local regulations controlling use of volatile organic compounds.

B. Samples for initial selection purposes in form of manufacturer's standard bead samples, consisting of strips of actual products showing full range of colors available, for each product exposed to view.

C. Certificates from manufacturers of joint sealants attesting that their products comply with specification requirements and are suitable for the use indicated.

D. Qualification data complying with requirements specified in "Quality Assurance" article. Include list of completed projects with project names addresses, names of Landscape Architects and Owners, plus other information specified.

E. Compatibility and adhesion test reports from elastomeric sealant manufacturer indicating that materials forming joint substrates and joint sealant backings have been tested for compatibility and adhesion with joint sealants. Include sealant manufacturer's interpretation of test results relative to sealant performance and recommendations for primers and substrate preparation needed to obtain adhesion.

F. Product test reports for each type of joint sealants indicated, evidencing compliance with requirements specified.

G. Preconstruction field test reports indicating which products and joint preparation methods

demonstrate acceptable adhesion to joint substrates.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed joint sealant applications similar in material, design, and extent to that indicated for Project that have resulted in construction with a record of successful in-service performance.

B. Single Source Responsibility for Joint Sealant Materials: Obtain joint sealant materials from a single manufacturer for each different product required.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealant manufacturer.
2. When ambient and substrate temperature conditions are outside the limits permitted by joint sealant manufacturer or below 40 deg F (4 deg C).
3. When joint substrates are wet.

B. Joint Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than allowed by joint sealant manufacturer for application indicated.

C. Joint Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

B. Colors: Provide color of exposed joint sealants to comply with the following:

1. Provide selections made by Landscape Architect from manufacturer's full range of

standard colors for products of type indicated.

2.2 URETHANE SEALANTS

A. Multi-Component Modified Polyurethane Sealant: Provide manufacturer's standard, polyurethane-based elastomeric sealant, complying with either ASTM C 920 Type M Class 25; self-leveling, otherwise nonsag.

2.3 MISCELLANEOUS MATERIALS

A. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming in any way joint substrates and adjacent nonporous surfaces, and formulated to promote optimum adhesion of sealants with joint substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealant performance. Do not proceed with installation of joint sealants until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with recommendations of joint sealant manufacturer and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint sealant manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings are installed.

D. Tooling of Nonsag Sealants: Immediately after sealant application and prior to time skinning or

curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

1. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.4 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so that and installations with repaired areas are indistinguishable from original work.

END OF SECTION

SECTION 32 14 16
UNIT PAVING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplemental Conditions and Division 1 Specification Sections apply to this Section.

1.02 SECTION INCLUDES

A. Work includes, but is not limited to, the following:
1. Provide new paving and edging as indicated on the Drawings.
Learning Court – **Base Bid**
Rectangular Field – **Add Alternate**
Brick Banding **– Add Alternate**
Brick Circle **- Add Alternate**

1.03 RELATED WORK

Division 31 – Earthwork

1.04 REFERENCES

A. Masonry work shall comply with ACI 530.1-95/ASCE 6-95 Specifications for Masonry Structures. Contractor shall maintain at least one copy of ACI 530.1-95/ASCE 6-95 on site.

1.05 QUALITY ASSURANCE

A. The Contractor performing the work of this Section shall have at least ten (10) years experience in new masonry paving installation and shall have completed at least three (3) projects of similar scope and scale within the previous five (5) years.

1.06 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product Data: submit manufacturers technical data for each manufactured product in the categories listed below, including certification that each product complies with specified requirements. Indicate that Installer has received copy of manufacturers' instructions. Product data shall include technical specification data, instructions for handling and use, and Material Safety Data Sheets.
1. Paving materials
2. Setting, pointing, and mortar materials.
3. Cleaning products.

C. Shop Drawings: The Contractor shall submit the following shop drawings for new masonry components. Shop drawings shall show unit dimensions, material indications, finish and fabrication information.
   1. Layouts drawings for paving at areas shown on drawings.

D. Maintenance data to include in the Maintenance Manual specified in Division 1 Section "Project Closeout."

E. Samples: submit samples for each color, grade, finish, type, and variety of paver consisting of:
   1. 12-inch-square units for paving.
   2. Include a minimum of three units in each set showing the full range of visual characteristics to be expected in the completed Work. Sample submittals will be reviewed for visual characteristics only. Compliance with all other requirements is the exclusive responsibility of the Contractor.
   3. Pointing mortar. Submit cured samples of pointing mortar to match that of the existing installation.
   4. Edging material as shown on drawing.

1.07 QUALITY ASSURANCE

A. Single Source Responsibility for Paver: Obtain each color, grade, finish, type, and variety of paver from a single source with resources to provide materials of consistent quality in appearance and physical properties, including capacity to cut and finish material without delaying the progress of the paver installation.

B. Single Source Responsibility for Setting Materials: Obtain mortar, grout, and dry-mix ingredients of uniform quality, and from one manufacturer for each cementitious and admixture component, and from one source or producer for each aggregate.

C. Field-Constructed Mockups: Build mockups, of full thickness, to comply with the following requirements:

   1. Locate mockups on site to show the following:
      a. Paver paving (each type) with related curbs, of a size not less than four (4) feet by four (4) feet and that clearly shows typical arrangements of pavers, and any special features for expansion joints and adjacent work. Provide range of color, texture, and workmanship to be expected in the completed work.
   2. Mockups are not to be part of actual work or incorporated into the final installation.
   3. Notify Landscape Architect 1 week in advance of each mockup construction.
   4. Obtain Landscape Architect's acceptance of mockup before proceeding with installation.
   5. Retain mockups during construction as a standard for judging installed paving and curbs. Do not alter, move, or destroy mockup until date of Final Acceptance.
      a. When directed by Landscape Architect, demolish and remove mockup from Project site.

1.08 DELIVERY, STORAGE AND HANDLING

A. Materials shall be delivered to the site in original packaging, unopened, with manufacturer's name and product identification thereon. Cementitious materials shall be protected from contamination by foreign matter and deterioration by moisture or temperature. Contaminated or deteriorated material shall not be used. Products stored longer than six months shall not be used.
   1. Store pavers on protected wood skids or pallets, covered with nonstaining, water-protective membrane. Place skids and stack pavers to distribute weight evenly and to prevent pavers from breaking or cracking.
   2. Allow air to circulate around pavers.
   3. Store cementitious materials off ground, under cover, and in a dry location.
   4. Store aggregate materials covered and in a dry location.

B. Masonry materials shall be stored in such a manner as not to interfere with the operation and daily maintenance of the facility. The Owner shall approve proposed material storage locations prior to the delivery of materials. Masonry materials shall not be stored inside the building.

C. Transport and store new paver materials in such a manner as to minimize handling prior to installation. Units that are cracked, chipped or otherwise damaged during Handling and storage shall not be installed in the work.

D. Handling: Handle paver to prevent chipping, breakage, soiling, or other damage. Do not use pinch or wrecking bars without protecting edges of paver with wood or other rigid materials. Lift with wide-belt type slings wherever possible; do not use wire ropes or ropes containing tar or other substances, which might cause staining. If required, use wood rollers and provide cushion at end of wood slides.

1.09 PROJECT CONDITIONS

A. The Contractor is responsible for protecting existing adjacent materials during the execution of the work. Provide all necessary protection and work procedures to avoid damage to existing material assemblies not a part of the work of this Section.

B. Provide visible barriers and / or warning tape around the perimeter of the work area.

C. Waste material, packaging and other debris associated with the work shall be disposed of in accordance with local, state and federal environmental regulations. Remove debris from work from the site and at the completion of the work.

D. The Contractor shall coordinate the work of this Section with other trades directly or indirectly affected by his work.

E. The Contractor is responsible for protecting existing adjacent materials during the execution of the work. Provide all necessary protection and work procedures to avoid damage to existing material assemblies not a part of the work of this Section. At a minimum, the Contractor shall:

1. Protect existing masonry components to remain in place from abrasion and
2. Prevent staining of pavers from other sources. Immediately remove such materials without damage to stonework.

F. Cold Weather Protection:
1. Do not set paver when air temperature or material temperature is below 50 deg F (10 deg C).
2. Maintain minimum ambient temperatures of 50 deg F (10 deg C) during installation and for 7 days after completion, unless higher temperatures are required by fabricator or supplier instructions.

G. Hot Weather Protection:
1. Protect masonry in hot weather to prevent excessive evaporation of cooling beds. provide artificial shade, wind breaks, and use cooled materials as required.

1.10 COORDINATION

A. The specialty nature of this project requires coordination of all trades necessary to complete the work. Construction of garden systems such as, but not limited to, structure, mechanical, and plumbing must be coordinated with the construction of fabrications and systems included in this Section.

1.11 SEQUENCING AND SCHEDULING

A. Sequence paving installation with adjoining and related work to avoid damage and soiling during construction.

PART 2 PRODUCTS

2.01 GENERAL

A. Comply with referenced standards and product requirements indicated and applicable to each paver type required.

C. Cut pavers to produce pieces of thickness, size and shape indicated or required and within fabrication tolerances recommended by applicable paver association.

D. Provide paver that is free of cracks, seams, and starts impairing structural integrity or function.

2.02 COMPACTED AGGREGATE BASE COURSE

A. Comply with referenced standards in Earthwork Section and product requirements indicated and applicable to each paver type required.

2.03 PEDESTRIAN BRICK PAVING
A. Type: Paver Brick
1. Manufacturer: **TBD**

2. Name: Paver Series-
3. Size: 4” x 8” x 2 ¼”
4. Colors: To Match Architectural Brick

2.05 PEDESTRIAN LEARNING COURT & FIELD PAVERS

A. Type: Unit Paver
1. Manufacturer: Techo-Bloc
2. Name: PARA 500 x 250
3. Size: 19 11/16” x 29 1/2” x 2 3/8”
4. Color: Beige Cream
5. Texture: Smooth

2.06 BRICK PAVER EDGING

A. Edging Material – Durawall edge restraint with mortar bed.

2.07 DRY-MIX MATERIALS

A. The dry-mix setting bed shall be placed under all paving types included in this Section and shall be screeded to a thickness of two (2) inches. Dry-mix joints between paving units shall be to the thickness noted on the Drawings. Dry mix shall be mixed in proportions by volume of one (1) part Portland Cement and three (3) parts Sand.

B. Portland Cement: ASTM C-150, Type I, except Type III may be used for cold weather construction. Provide gray or white cement as needed to produce mortar color as required.

D. Aggregate: ASTM C-144, clean masonry

2.08 MORTAR MATERIALS

A. Portland Cement: ASTM C 150, Type I, non-staining and without air entrainment. Gray and white Portland cement may be combined as required to match the desired color.

B. Hydrated Lime: ASTM C 207, Type S and Type N.

C. Sand: ASTM C 144, free of clay, silt, soluble salts and organic matter and shall match the color and texture of the original mortar sand. The Contractor may request from the Landscape Architect a sample of the original mortar sand for use in color and texture matching.

D. Water: Potable, free from injurious amounts of oil, soluble salts, alkali, acids, organic impurities and other deleterious substances which impair mortar strength or bonding.

B. Admixtures: No admixtures are permitted.

F. Pigments: Commercial iron-oxide, manganese dioxide, ultramarine blue, chromium oxide, or carbon black, suitably compounded for use in mortar mixes.

G. Mortar Mixes:

Edging Mortar

Type N mortar shall be mixed in the following proportions:
1 part hydrated lime by volume
1 part Portland cement by volume
6 parts sand by volume

2.09 MIXING PROCEDURES

A. General: Comply with referenced standards and with manufacturer's instructions related to mix proportions, mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortars and grouts of uniform quality and with optimum performance characteristics.

1. Do not add admixtures including air-entraining agents, accelerators, retarders, water-repellent agents, anti-freeze compounds, or calcium chloride, unless specifically approved in writing by the Landscape Architect.
2. Combine and thoroughly mix cementitious materials, water and aggregates in a mechanical batch mixer; comply with referenced ASTM or ANSI standard, as applicable, for mixing time and water content.

B. Mix mortars in accordance with ASTM C 270. Measure materials by volume or equivalent weight. Do not measure by shovel.

C. Mix ingredients in a clean mechanical batch mixer for a minimum of 3 to 5 minutes.

D. Mortar shall be pre-hydrated to reduce shrinkage. Lime and sand shall be thoroughly mixed, adding only enough water to produce a damp, unworkable mix, which will retain its form when pressed into a ball. Mortar shall stand in this condition for 1 hour. Add Portland cement and remainder of water and mix to provide a workable mortar consistency. Place mortar in final position within two hours of mixing. Do not re-temper or use partially hardened mortar.

2.10 PAVER ACCESSORIES

B. Cleaner: Provide paver cleaners specifically formulated for paver types, finishes, and applications indicated as recommended by paver producer. Do not use cleaning agents containing acid or cleaning compounds and solutions containing caustic or harsh fillers, except where expressed by written approval from paver producer for paver type condition.

PART 3 EXECUTION

3.01 GENERAL

A. Examine areas and conditions under which work is to be performed. Notify the Landscape Architect of any conditions detrimental to the proper and timely completion of the work. Do not commence work until all unsatisfactory conditions have been adequately corrected.

B. Coordinate removal and replacement of drains, furnishings, and any other components.

3.02 INSTALLATION, GENERAL

A. Do not use paving units with chips, cracks, voids, and other defects which might be visible or cause straining in the finished work.

B. Do not use new paver units with discolorations, unless approved as natural variations in color by the Landscape Architect.

C. Cut paving units with motor-driven saw equipment designed to cut masonry with clean, sharp, and un-chipped edges. Cut units as required to provide pattern shown and to fit adjoining work neatly. Use full units without cutting wherever possible.

D. Clean and wet paving units prior to installation, to ensure integrity of mortar and grout bonds.

E. Set paving units in the patterns shown and with uniform joints of width indicated on the Drawings.

F. Tolerances: Maintain surface plane for finished unit paving not exceeding a tolerance of 1/8" in ten (10) feet when tested with a ten (10) foot straight-edge.

G. Landscape Architect reserves the right to reject paver units not conforming to structural or visual characteristics outlined in this Section.
   a. Contractor shall replace rejected paver units at no additional cost to the Owner.
   b. Replaced paver units are subject to approval by the Landscape Architect.

3.03 INSPECTION & PREPARATION

A. Verify compacted subgrade is dry and ready to receive work of this Section. The finished sub-base course shall be approved before placement of any base course

B. Verify gradients and elevations of base course are correct. The base course shall be spread in layers which when compacted shall not exceed 4".

C. The base course shall be compacted uniformly to the thickness indicated on the Drawings. Compact base course to 100% of ASTM D-1557 maximum laboratory density.

D. The final elevations of the compacted base courses shall allow for thickness of setting beds and for curbing units to maintain the finished curbing elevations as noted on the Drawings.

E. After installation of new base slab and topping slab are complete, inspect substrate for integrity of the surface and the presence of protrusions and/or depressions that may affect the placement of the unit curbing. Remove protrusions flush with surrounding surfaces. Fill depressions level with surrounding surfaces.

F. Verify slope of underlying slab to ensure adequate drainage away from the building line and toward designated drainage points.

G. Coordinate removal and replacement of drains, furnishings and other components.

H. Beginning of installation means acceptance of existing conditions.

3.04 INSTALLATION OF PAVING UNITS ON DRY SETTING BED

A. Place dry-mix setting bed where shown. Screed loose to depth required to allow for setting and tamping of paving units. Make sure bed remains loose until paving units are set and compacted.

B. Take adequate precautions to prevent dry-mix setting bed from getting wet before or during installation of paving.

B. Do not disturb leveling course while placing paving units. Use block-splitter to cut edges when full size paving units cannot be used. Select pavers from 4 or more units to blend color and texture variations.

3.05 REPAIR AND CLEANING

A. Defects: Remove paver units with the following defects:
   1. Broken, chipped, stained, or otherwise damaged pavers.
   2. Defective joints.
   3. Pavers and joints not matching approved samples and field constructed mockup.
   4. Paver not complying with requirements indicated.

B. Replacement: Replace damaged paver with new units to match approved samples and field constructed mockups without evidence of replacement. Patching or hiding defects in paver will not be permitted.

C. Cleaning: Clean paver installations after setting, pointing, grouting, and curing are complete. Use procedures recommended by paver producers for types of application. Repoint any open joints with mortar specified for the particular application.

3. 06 PROTECTION

A. Protect paver surfaces, edges, and corners from damage during subsequent construction activities, and from other materials that would cause stains.

B. Provide protection for all finished stonework liable to physical injury or staining. Protection shall include, but is not limited to, non-staining approved coverings, and clean non-staining

wood boxing. All fastenings or hold-back devices shall be galvanized steel. Fastening to stonework in any manner is prohibited.

C. Before inspection for Final Acceptance, remove protective covering and clean surfaces using procedures, products, and materials recommended by paver producers.

D. Examine all work and repair all damage. In the event damage is irreparable, or soiled or stained surface cannot be cleaned, then remove and replace such items at no additional cost to Owner.

E. Protect paver surfaces, edges, and corners from damage during subsequent construction activities, and from other materials that would cause stains.

F. Provide protection for all finished stonework liable to physical injury or staining. Protection shall include, but is not limited to, non-staining approved coverings, and clean non-staining wood boxing. All fastenings or hold-back devices shall be galvanized steel. Fastening to stonework in any manner is prohibited.

END OF SECTION

SECTION 32 16 00

CURBS AND GUTTERS

PART 1 - GENERAL

1.01 SUMMARY

A. Provide curbs along edges of roadways over compacted gravel base.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Test Reports: Submit for approval test reports.

1.03 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

B. Construction Tolerance: 1/8" in 10' for grade and alignment; 1/4" in 10' for vertical or sloped face on longitudinal axis.

C. Mock-Ups: Provide mock-up as required to demonstrate quality of workmanship.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Precast Concrete:

1. Concrete: ASTM C 150, Type I, Portland Cement; ASTM C 33, normal weight aggregates; potable water.
2. Design Mix: ASTM C 94, 3000 psi, 28 day minimum compressive strength.
3. Finish: Smooth form finish.
4. Reinforcing Bars: Deformed steel bars, ASTM A 615, Grade 60.
5. Joint Dowel Bars: Plain steel bars, ASTM A 615, Grade 60.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide acceptable materials and install curbing in strict compliance with local DOT and DPW Standard Specifications for Highways and Bridges.

B. Set curbs on compacted gravel subbase with joints between curb pieces from 1/8" to 3/4" wide. Point joints with mortar and tool concave; remove surplus mortar and clean curbs.

END OF SECTION

SECTION 32 18 13
SYNTHETIC TURF

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 all labor, materials, equipment, and tools necessary for the complete installation of synthetic grass surface. The system shall consist of, but not necessarily be limited to, the following:

1. Synthetic grass consisting of fibers that are a minimum of 1.54 inch long. Turf fiber construction consisting of polyethylene monofilament and either texturized monofilament fibers tufted to a 2-layer stabilized woven polypropylene fabric (primary backing), with a non-urethane, 100% recyclable secondary backing (stitch binder) of DuraFlo. (XGrass® synthetic turf or equivalent).

2. Synthetic Grass Infill, consisting of anti-microbial acrylic coated round silica particles, designed to provide the look, feel, and performance of optimally maintained natural grass. Envirofill™ or equivalent.

B. Related Sections:
1. Section 321312 – Site Concrete

1.3 SUBMITTALS

A. Product Data

1. Submit manufacturer's product data, including installation instructions and subsurface instructions.

2. Samples: Submit samples of synthetic grass and infill.

3. Warranty: Submit manufacturer's standard 10 year warranty.

PART 2 - PRODUCTS

2.1 SYNTHETIC GRASS SURFACE

A. Aggregate Base – Crushed angular hard stone, ¾"minus compactible stone (not clean) or clean stone with top layer of compacted fines. (Refer to Section 3.2-C)

B. Synthetic grass: 1.75" XGrass® Synthetic Turf for Landscapes from XGrass, 1224 Howell Drive, Dalton, GA 30721 Phone (877) 881-8477 or approved equal.
a) Face Weight Minimum 50 oz/sy
b) Face Yarn Type: Polyethylene
c) Yarn Size 10800/7300
d) Pile Height: 1.75 inches

e) Color: Blend
f) Construction: Broadloom tufted
g) Tufting Gauge: 1/4”
h) Primary Backing: Stabilized dual layered woven polypropylene
i) Secondary Backing 10.0 oz. DuraFlo (non-urethane, 100% recyclable)
j) Total Product Weight 69.7 oz/sy
k) Finished Roll Width 180” untrimmed
l) Warranty: 10 year fade

C. Synthetic Grass Infill : EnviroFill™ from XGrass, 1224 Riverbend Road, Dalton, GA 30721 : Phone (877) 881-8477 or approved equal. Coating: Priority acrylic with Microban®, iron oxide and chromium oxide.
a) Grain shape: Hardness: 6-8 Mohs
b) Curvature: 0.7+
c) Specific Gravity: 1.76 g/cm3
d) Bulk Density: 110 lb/cu ft
e) Uniform coefficient 1.10 to 1.40
f) Effective Size .84 – 1.681 mm

D. Splicing Material: 1000 denier coated nylon (Cordura®) 12” wide minimum.

F. Adhesive: Synthetic Turf Adhesive (from XGrass)

PART 3 - EXECUTION

3.1 GROUND PREPARATION

A. General: The ground area to receive synthetic grass surface is indicated on the Drawings.

B. Leveling and Site Preparation: All organic material and organic debris to be removed. Soil to be graded level and stabilized (compacted). Compaction shall be done with mechanical compactors, including vibratory compactors, and/or powered tampers, and rollers.

3.2 BASE AND SYNTHETIC GRASS CONSTRUCTION

A. General: The area to be smooth and graded to allow for proper drainage. Refer to engineered grading plan if available. The overall grade of the playground is not to exceed 3%.

B. Nailer Board: Installation of pressure treated or composite board per site requirements.
a) Concrete edges: Nailer board attached directly to vertical concrete edge with a Tapcon hardware situated 3/4” below concrete grade.
b) Non-concrete edges: Nailer board installed with round, steel stake, 3 per 10’ board. Top of nailer boards to be situated 3/4” below grade.

C. Compacted Aggregate Base: Place 3“ of 3/4” clean aggregate base and 1” of screening as leveling layer compacted to 90% of max density per AASHTO T99 or 3/4” minus compactible stone. Compaction shall be done with mechanical compactors, including vibratory compactors, and/or powered tampers, and rollers.

D. Synthetic Grass: Place turf and cut to fit configuration as shown on Drawings. Splice seams. All seams must be attached with splicing film/fabric and adhesive as approved by the manufacturer for this type of installation of their product.

E. Anchoring/Edging: Edges of turf will be secured to nailer board perimeter.

F. Infill: Apply layers of synthetic grass infill evenly with a spreader and broom the turf fibers with stiff bristle broom to stand fibers up and allow infill to settle into the bottom. Broom in infill round quartz silica sand approximately 3 pounds per square foot.

END OF SECTION

SECTION 32 30 00

SITE IMPROVEMENTS AND AMENITIES

PART 1 - GENERAL

1.01 SUMMARY

A. Provide site improvements and furnishings.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Shop Drawings: Submit shop drawings indicating material characteristics, details of construction, connections, and relationship with adjacent construction.

1.03 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide units specifically designed for exterior exposure and intended use:

1. Walkway, Roadway, and Parking Appurtenances: Custom design.
2. Site Signage: Directional or informational signage; multilingual as applicable to area.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials and systems in proper relation with adjacent construction and with uniform appearance. Coordinate with work of other sections.

B. Restore damaged finishes and test for proper function. Clean and protect work from damage.

END OF SECTION

SECTION 32 31 00

FENCES AND GATES

PART 1 - GENERAL

1.01 SUMMARY

A. Provide chain link fencing and gates for areas requiring separation.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Samples: Submit two representative samples of each material specified indicating visual characteristics and finish. Include range samples if variation of finish is anticipated.

1.03 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Steel Chain-Link Fence Fabric:

1. Mesh and Wire Size: 2 inch mesh, 0.148 inch diameter (9 gauge).
2. Coating: ASTM A 817, Type 2, Class 1, zinc-coated (galvanized) applied after weaving.

B. Framework:

1. Galvanized steel, ASTM F 1083.

C. Gates:

1. Swinging type.

D. Framing and Fittings:

1. End, corner, and pull posts.
2. Line and intermediate posts.
3. Gate posts.
4. Top rail.
5. Tension wire.
6. Tie wires.
7. Post and line caps.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install materials in accordance with manufacturer's instructions and approved submittals. Comply with ASTM F 567. Install materials in proper relation with adjacent construction and with uniform appearance. Coordinate with work of other sections. Install posts to depth to avoid frost heave.

B. Cut pipe with pipe-cutters only. Cutting with backsaws is not acceptable. Tack weld gates for strength. Use spring loaded latches, not yokes.

C. Restore or replace damaged components. Clean and protect work from damage.

END OF SECTION

SECTION 32 31 19
DECORATIVE METAL FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Decorative steel fences.

B. Matching steel sliding gates.

C. Gate operators and controls.

1.02 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2017.

B. ASTM F2408 - Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets; 2016.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to start of work of this section; require attendance by affected installers.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

B. Shop Drawings:
   1. Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.
   2. Foundation details, concrete design mix and reinforcing schedule for anti-ram barrier system.

C. Installer's Qualification Statement.

D. Manufacturer's Warranty.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

B. Installer Qualifications: Experienced with type of construction involved and materials and techniques specified and approved by fence manufacturer.

1.07 DELIVERY, STORAGE AND HANDLING

A. Store materials in a manner to ensure proper ventilation and drainage. Protect against damage, weather, vandalism and theft.

1.08 WARRANTY

A. Finish: 10 years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Decorative Metal Fences and Gates:
   1. Ameristar Perimeter Security, USA: www.ameristarfence.com.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 FENCES

A. Fences: Complete factory-fabricated system of posts and panels, accessories, fittings, and fasteners; finished with electrodeposition coating, and having the following performance characteristics:

B. Electro-Deposition Coating: Multi-stage pretreatment/wash with zinc phosphate, followed by epoxy primer and acrylic topcoat.
   1. Total Coating Thickness: 2 mils (0.058 mm), minimum.

C. Steel: ASTM A653/A653M; tensile strength 45,000 psi (310 MPa), minimum.
   1. Hot-dip galvanized; ASTM A653/A653M, G60.
   2. 62 percent recycled steel, minimum.

2.03 WELDED STEEL FENCE

A. Provide fence meeting requirements for Industrial class as defined by ASTM F2408.

B. Fence Panels: Fusion welded; 8 feet (2.4 m) high by 8 feet (2.4 m) long.
   1. Panel Style: As shown.
   2. Attach panels to posts with manufacturer's standard panel brackets.

C. Posts: Steel tube.
   1. Size: 3 inches (76 mm) square by 12 gage, 0.109 inch (2.76 mm thick), with manufacturer's standard cap.
   2. Post Cap: Flush plate.

D. Rails: Manufacturer's standard, double-wall steel channel 1-3/4 inch (44.5 mm) square by 12 gage, 0.1094 inch (2.76 mm thick) with pre-punched picket holes.
   1. Picket Retaining Rods: 0.125 inch (3.17 mm) galvanized steel.
   2. Picket-to-Rail Intersection Seals: PVC grommets.

E. Pickets: Steel tube.
   1. Spacing: 3-3/4 inch (95.2 mm) clear.
   2. Size: 1 inch (25.4 mm) square by 18 gage, 0.0478 inch (1.21 mm thick).
   3. Style: Pickets with finial extend above top rail.
   4. Finial: Spear point.

F. Flexibility: Capable of following variable slope of up to 1:2.

G. Gates: Vehicular (single sliding) gate.
   1. Ornamental Picket Cantilever Gate.
   2. Match design of fence.
   3. Size: As shown.
   4. Product: TransPort II as manufactured by Ameristar Perimeter Security, USA

2.04 ACCESSORIES

A. Gate Operator:
   1. 1 HP continuous-duty motor:
      a. Maximum gate width: 22-ft. (1 HP).

b. Maximum gate weight: 800 pounds* (1 HP).
2. 1 HP continuous-duty motor.
3. 115, VAC.
4. Class I, II, III and IV applications.
5. Dimensions: 18.38"W x 31.63"H x 23.25"D
6. Adjustable, no maintenance magnetic limits.
7. Overlap feature for bi-parting swing gate operation.
8. Simple connection for secondary operator in bi-parting applications.
9. Selectable shadow/reverse loop function.
10. Magnetic lock power provided.
11. Ports for plug-in loop detectors.
12. Three 115 VAC convenience outlets.
13. Gate tracker reporting output.
14. Programming switches.
15. Built-in reset switch.
16. Built-in power On/Off switch.

B. Gate Controls:
1. Key pad control.
2. AI Phone.
3. Knox Box.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Set fence posts in accordance with the manufacturer recommended spacing.

C. When cutting rails immediately seal the exposed surfaces by:
1. Removing metal shavings from cut area.
2. Apply zinc-rich primer to thoroughly cover cut edge and drilled hole; allow to dry.
3. Apply two coats of custom finish spray paint matching fence color.
4. Failure to seal exposed surfaces in accordance with manufacturer's instructions will negate manufacturer's warranty.

D. Space gate posts according to the manufacturers' drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected.
1. Base type and quantity of gate hinges o the application; weight, height, and number of gate cycles.
2. Identify the necessary hardware required for the application on the manufacturer's gate drawings.
3. Provide gate hardware by the manufacturer of the gate and install in compliance with manufacturer's recommendations.

3.04 ERECTION TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch (6.3 mm).

B. Maximum Offset From Indicated Position: 1 inch (25.4 mm).

C. Minimum Distance from Property Line: 6 inches (152 mm).

3.05 CLEANING

A. Leave immediate work area neat at end of each work day.

B. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.

C. Clean fence with mild household detergent and clean water rinse well.

D. Touch up scratched surfaces using materials recommended by manufacturer. Match touchup paint color to fence finish.

3.06 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair, or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 32 91 13
TOPSOILING

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. Prepare subsoil.
2. Furnish and place topsoil for turf areas and planting beds.

B. Related Sections:

1. Section 329115 – Amended Soil
2. Section 029200 - Turf and Grasses
3. Section 329300 – Planting

1.3 STANDARDS

A. The quality of materials and performance of work specified in this section shall be in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction, January, 1998.

1. Section 733: Topsoiling

1.4 SUBMITTALS

A. Legal Documents

1. Submit a complete materials list of items to be provided under this section for approval by the Owner's Representative before the purchase of any material.
2. Submit a list of proposed methods of execution of work under this section for approval by the Owner's Representative when proposed methods are different from or supplementary to those specified herein.
3. Submit copies of soil test recommendations called for in this section.

B. Delivery Slips

1. Submit delivery slip for all shipments of topsoil showing the product volume and name of supplier.

1.5 PRODUCT DELIVERY AND STORAGE

A. Obtain all legal rights or easements necessary from private owners on whose lands topsoil may be stored. Furnish rights or easements in written form and signed by both CONTRACTOR and property OWNER involved, or their duly authorized representatives.

B. Fertilizer and lime shall be delivered and stored in original unopened packages, kept dry, and not opened until needed for use. Damaged or faulty packages shall not be used.

1.6 JOB CONDITIONS

A. Existing Conditions

1. Perform topsoiling only after preceding work affecting ground surface is completed.

B. Environmental Requirements

1. Topsoil shall not be moved or spread in frozen or muddy condition.

C. Protection

1. Protect trees and shrubs to remain as part of final landscaping against damage.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. Existing Topsoil - Topsoil may be reused from site excavation with approval from Owner's Representative. See Section 2810- Amended Planting Soil.

B Imported Topsoil - Where additional topsoil is not available or insufficient, topsoil may be imported. Representative samples will be made available by the contractor for testing.

Imported topsoil shall be Enriched Horticultural Topsoil by Laurel Valley Soils or approved equal meeting the following requirements:

1. Natural loam topsoil free from subsoil, obtained from an area that has never been stripped. It shall be of uniform quality, free from hard clods, stiff clay, sods, stone, lime, cement, ashes, slag, or other undesirable material.

2. Organic matter shall fall in the range of 5 – 10%, determined by loss of ignition of moisture-free samples dried in accordance with the current method of the Association of Official Agricultural Chemists. The acidity range shall be pH 5.0 to 7.0 inclusive. Maximum soluble salts: 500 ppm. The mechanical analysis of the soil shall be as follows:

Passing	Retained	Percentage
1" screen	--	100
1" screen	¼" screen (gravel)	3 (maximum)
¼" screen	No. 100 U.S.S. mesh sieve (sand)	40 – 60
No. 100 U.S.S. mesh sieve sand	Very fine sand, silt, or clay	3 – 60

4. The Contractor shall furnish certified report(s) of the testing laboratory showing the analysis of a representative sample of the topsoil. A separate report shall be furnished for each source of topsoil. The Contractor shall furnish the reports to the Owner's Representative before any topsoil is delivered to the site.

5. The Owner's Representative reserves the right to reject topsoil in which more than 60 percent of the material passing the No. 100 U.S.S. Mesh Sieve consists of clay as determine by the Bouyoucous hydrometer or by the Decantation method. All percentages are to be based on dry weight of sample. If the Owner's Representative directs, topsoil which varies only slightly from the Specifications may be acceptable by such corrections, as the Owner's Representative deems necessary.

6. All topsoil shall have a range of pH from 5.5 to pH 6.2.

7. Topsoil shall contain no more than 10% organic matter as determined in accordance with the AASHTO T 267 test method. The following nutrients shall fall within the ranges listed:

   Soluble salts shall not exceed 300 ppm/0.9 mmhos/cm.
   Cation Exchange Capacity (CEC) 8 or greater.
   Carbon/Nitrogen Ratio less than 20:1.
   The following elements shall not exceed the indicated amount:
   Iron 3ppm
   Boron 0.5 ppm
   Manganese 2ppm
   Potassium 200ppm
   Sodium 40ppm
   Copper 0.4 ppm
   Zinc 1.5 ppm
   Molybdenum 0.15ppm
   Magnesium – Mg 25-100ppm
   Phosphorus – P 5-30ppm
   Potassium – K 50-200ppm
   Calcium – Ca 75-300ppm

8. Toxic elements and compounds shall be below a maximum level as recommended by the approved soil testing facility for the plants being grown.

9. Acceptable mechanical ranges for topsoil:

   Sand 45-65%

   Silt 20-35%

   Clay 10-20% Pore space, 35 – 50 percent.

   Permeability shall not be less than 1" per hour.

   If sand is used, an angular quartz sand such as NJ#3 from US Silica is required.

2.2 SOIL AMENDMENTS PER SOIL TEST RECOMMENDATIONS

A. Dolomite Lime: Shall be agricultural grade mineral soil conditioner containing 35% minimum magnesium carbonate and 49% minimum calcium carbonate, 100% passing No. 65 sieve, Kaiser Dolomite 65 AG or approved equal.

2.3 PLANTING SOIL MIX

A. See Section 02810 AMENDED PLANTING SOIL.

PART 3 - EXECUTION

3.1 SITE PREPARATION

A. Do not proceed with topsoiling until conditions are satisfactory.

B. Verify that clearing, earthwork, grading and other preceding work affecting ground surface have been completed and approved by landscape architect or Owner's Representative.

1. Final subgrade elevation and contours shall be smooth and uniform to required lines and elevations. All variations, lumps, ridges, and depressions in subgrade shall be corrected before topsoil work is started. Remove all stones, clods, lumps two inches or larger in any dimension; remove all wires, cables, pieces of concrete, tree roots, and debris or other unsuitable material.

2. Do not move heavy objects over the proposed subgrade planting areas.

C. At the discretion of the Owner's Representative, obtain analysis from an accredited soils lab at the Contractor's cost.

D. The subsoil shall be loosened to a depth of no less than 6", or as directed by the Owner's Representative.

3.2 SOIL TESTING

A. Complete soil test for all topsoil to be reused from project site.

B. Soil samples shall be submitted to a testing facility capable of all testing required under these specifications and approved by Landscape Architect.

C. The soil test should determine mechanical analysis, soluble salt level, N,P,K, levels, pH, organic matter content, cation exchange, and mico- nutrient levels, bulk density. For off-site sources of topsoil, proctor analysis and chemical residue contamination screening are required.

D. Submit soil test rests from an approved soil testing laboratory from a representative sample of the proposed imported topsoil to landscape architect for approval a minimum of 30 days in advance of plans to transport it to the site.

E. Submit a physical sample of 1 gal. soil for each soil type/mix to be provided. This is in addition to submittals to analytical labs, made by contractor.

F. Contractor shall submit to landscape architect for approval source of topsoil (if natural to be obtained from within 75 miles of project site) or if manufactured soil submit name and location of manufacturer.

3.3 COORDINATION

A. Placement of soil media shall:

1. NOT be performed when sub-grade surfaces are porous, wet, frozen or spongy.

2. Be placed to maintain optimum moisture content of backfill materials to attain required compaction density.

3. Employ a placement method that does not disturb or damage other work, existing conditions, or surrounding soils.

B. Before placing or depositing soil media upon any area as shown on the plans, the sub-base shall be approved by landscape architect.
1. Subsoil shall be loosened to a depth of 6" by mechanical means.

2. Add remainder of soil media to depths specified.

3.4 SUBGRADE PREPARATION

A. 1. Scarify subgrade by tilling planting beds to a uniform depth of not less than four inches (4") and not more than six inches (6") prior to placement of topsoil unless directed otherwise by the Landscape Architect. Remove all vegetation, debris, unsuitable soil materials, obstructions, and deleterious materials from scarified soil. Legally dispose of all debris off Owner's property.

2. Plow, strip, or break-up sloped surfaces steeper than one (1) vertical to four (4) horizontal to a depth of not less than six inches (6") so that fill material will bond with existing surface.

3. When existing ground surface has a density less than that specified under "Compaction," for the particular area classification, break up the ground surface, pulverize, moisture-condition to the optimum moisture content, and compact to required depth and percentage of maximum density.

3.5 MOISTURE CONTROL

A. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material.

1. 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. revent free water appearing on surface during or subsequent to compaction operations.

2. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

3. Puddling or jetting shall not be permitted.

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

3.6 PLACING TOPSOIL

A. Plan sequence of work to minimize compaction of soil and ensure that no heavy equipment will run across finished surfaces. Sequence of work must ensure a uniform profile and prevent localized compaction. (For example, work performed to back machines out of areas where work occurs.) Soil media shall be spread on these areas to a depth sufficiently greater than that specified on the plans. After natural settlement has taken place, the work must be in close conformity to acceptable compaction tolerances and finish grade or meet surrounding edge conditions.

B. Topsoil or Amended Planting Soil shall be installed and incorporated in six inch lifts to the following total depths, or as indicated on the drawings:

1. 6 inch minimum for turf areas;

2. 12 inch minimum for other planting areas, including perennial beds and specimen trees.

Each lift shall be compacted to specified percent that will generally not exceed 85% - evenly through the profile. The final elevation of the soil media shall be based on a specified compaction rate and shall correspond to elevations shown on the plans.

C. Final soil grades in flat areas will result in slight crowning of the soil, while grades on other areas will be with the intent of guiding runoff to drainage

D. Remove stones, lumps, roots and other objects larger than one inch in any dimension from graded topsoil surface.

3.7 DEWATERING

See Division 2 Section “Earth Moving” for dewatering measures

3.8 STORAGE OF SOIL MATERIALS

A. Stockpile satisfactory salvaged surface soil materials as well as imported topsoil, compost, soil amendments, etc. Stockpile 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.

Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
1. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil mix.
2. Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Rake, remove ridges, and fill depressions to meet finish grades.

B. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.

3.9 UTILITY TRENCH BACKFILL

A. After utility trench has been backfilled satisfactorily to subgrade, fill trench to finished grade with topsoil. To the following depths:

1. Under proposed lawn areas: min. 6 inches of topsoil

2. Under proposed plant beds: min.12 inches of topsoil.

4.0 COMPACTION OF BACKFILLS AND FILLS

A. See Division 02 Section Earth Moving for specifications regarding backfill and fill.

B. For the upper level of subgrades under lawn and plant bed areas, compact soil to not less than the following percentages of maximum dry density for soils which exhibit a well-defined moisture density relationship determined in accordance with ASTM D-1557; and not less than the following percentages of relative density determined in accordance with ASTM D-2049, for soils which will not exhibit a well-defined moisture-density relationship.

1. Lawn or Unpaved Areas: Compact top six inches (6") of subgrade and each layer of backfill or fill material at 90 percent (90%) maximum dry density.

2. Trench Stabilization Materials: Compact each layer of material to 95 percent (95%) of maximum dry density.

4.1 FINE GRADING

A. General: Uniformly grade topsoiled areas to a smooth surface, free from 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.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

4.2 PROTECTION

A. When required, erect temporary signs and barriers to protect topsoiled area.

4.3 MAINTENANCE

A. Immediately before establishment of planting material, re-topsoil and re-grade areas which become eroded, settled or otherwise disturbed.

B. Perform all maintenance work in accordance with the Specifications without additional compensation.

C. Maintenance period to extend until installation of planting material.

4.4 CLEANING

A. Immediately clean spills, soil, and conditioners on paved and finished areas.

B. Haul and dispose of topsoil in excess of the quantity required for the project off site.

C. Dispose of protective barricades and warning signs at termination of maintenance period.

END OF SECTION

SECTION 32 91 15
AMENDED PLANTING SOIL

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. Amending of existing soil to prepare for installation of planting beds, turf, and specimen trees.

Related Sections:

1. Section 329113 – Topsoiling
2. Section 329200 – Turf and Grasses
3. Section 329300 – Planting

1.3 STANDARDS

A. The quality of materials and performance of work specified in this section shall be in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction, January, 1998.

1. Section 733: Topsoiling

1.4 SUBMITTALS

A. Legal Documents

2. Submit a complete materials list of items to be provided under this section for approval by the Owner's Representative before the purchase of any material.
3. Submit a list of proposed methods of execution of work under this section for approval by the Owner's Representative when proposed methods are different from or supplementary to those specified herein.
4. Submit copies of soil test recommendations called for in this section.

B. Delivery Slips

1. Submit delivery slip for all shipments showing the product volume and name of supplier.

1.5 PRODUCT DELIVERY AND STORAGE

A. Obtain all legal rights or easements necessary from private owners on whose lands topsoil may be stored. Furnish rights or easements in written form and signed by both CONTRACTOR and property OWNER involved, or their duly authorized representatives.

1.6 JOB CONDITIONS

A. Existing Conditions

1. Perform work in this scope only after preceding work affecting ground surface is completed.
2. Verify locations of all underground utilities prior to start of work.

B. Environmental Requirements

1. Topsoil shall not be moved or spread in frozen or muddy condition.

C. Protection

1. Protect trees and shrubs to remain as part of final landscaping against damage.

PART 2 - PRODUCTS

2.1 COMPOST

A. Compost shall be certified by US Composting Council as STA Organic Compost. Laboratory results of submittal sample shall satisfy the following:

Soluble Salts no greater than 10 mmhos/cm

% solids content 50-60% (50-40% moisture)

Organic matter 30-60%

Nitrogen 0.5-2.5 %(dry weight basis)

pH 5.0 to 8.0

Total Carbon up to 55% by weight

C:N Ration less than 20% dry weight basis

Pass select pathogens and Trace Metals

Bio Assay >95%

2.2 SOIL AMENDMENTS TO ALTER pH AS PER SOIL TEST RECOMMENDATIONS

A. Dolomite Lime: Shall be agricultural grade mineral soil conditioner containing 35% minimum magnesium carbonate and 49% minimum calcium carbonate, 100% passing No. 65 sieve, Kaiser Dolomite 65 AG or approved equal.

2.3 TOPSOIL

If, after completion of soil amendments, soil volume is insufficient to meet finish grades then topsoil may be imported to job site. See Section 02800 - TOPSOILING.

2.4 PLANTER SOIL MIX

A. Planter Soil Mix: Mix topsoil with the following soil amendments and fertilizers in the following quantities:

Ratio of Loose Compost to Topsoil by Volume: 1:4 parts

Weight of Slow-Release Fertilizer per 1000 Sq. Ft.: 1 to 2 pounds of water-insoluble nitrogen with a NPK ratio of either 3-1-2 or 3-1-1, unless otherwise indicated by soil tests.

PART 3 - EXECUTION

3.1 PREPARATION

A. Do not amend or place any soil or soil amendments until conditions are satisfactory. No work shall be performed when existing conditions are porous, wet, frozen or spongy.

B. Verify that clearing, earthwork, grading and other preceding work affecting ground surface have been completed and approved by Landscape Architect or Owner’s Representative.

3.2 SOIL TESTING

A. Complete soil test through approved soil testing laboratory from a representative sample of all existing soil to remain on project site in planting beds or turf areas. The soil test should determine mechanical analysis, soluble salt level, N,P,K, levels, pH, organic matter content, cation exchange, micro- nutrient levels, and bulk density. Submit soil test results for approval by Landscape Architect.

B. Submit lab test results from an approved soil testing laboratory from a representative sample of the proposed imported compost to Landscape Architect for approval a minimum of 30 days in advance of plans to transport it to the site.

C. Submit source of compost (name and location) to Landscape Architect for approval.

D. Submit a physical sample of 1 gal. compost to be provided. This is in addition to submittals to analytical labs made by contractor.

3.3 COORDINATION

A. Coordinate work to maintain optimum moisture content of materials and existing soil to attain required compaction density.

1. Employ a placement method that does not disturb or damage other work, existing conditions, or surrounding soils.

2. Do not move or set heavy objects over proposed planting areas at any time during project sequence.

3.4 INSTALLATION FOR PLANTING BEDS ONLY (NOT PLANTERS)

A. Plan sequence of work to minimize compaction of soil and ensure that no heavy equipment will run across finished surfaces. Sequence of work must ensure a uniform profile and prevent localized compaction. (For example, work performed to back machines out of areas where work occurs.) Soil media shall be spread on these areas to a depth sufficiently greater than that specified on the plans. After natural settlement has taken place, the work must be in close conformity to acceptable compaction tolerances and finish grade or meet surrounding edge conditions.

B. Final soil grades in flat areas will result in slight crowning of the soil, while grades on other areas will be with the intent of guiding runoff to drainage

C. Remove stones, lumps, roots and other objects larger than one inch in any dimension from graded surface.

3.5 DEWATERING

A. See Section “Earth Moving” for dewatering measures

3.6 STORAGE OF MATERIALS

A. Stockpile materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust or importation of weed seed.

1. Stockpile materials away from edge of excavations. Do not store within drip line of remaining trees.

3.7 AMENDING SOIL FOR PLANTING BED AREAS

A. Loosen existing soil in planting beds to a minimum depth of 12 inches. Loosen existing soil in

turf areas to a depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

B. All planting beds shall be amended by spreading horticultural compost over loosened surface to uniform depth of 3”. Incorporate compost with existing soil by tilling to a depth of 6 to 8 inches. If required to meet finish grades, place imported topsoil over amended planting soil. If required as per soil test results, apply soil amendments to alter pH and thoroughly blend into planting bed.

C. Grade planting beds to a smooth, uniform surface with loose, uniformly fine texture. Rake, remove ridges, and fill depressions to meet finish grades.

D. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.

3.8 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.

1. Do not place compost 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.

3.9 COMPACTION

A. See Section Earth Moving for specifications regarding backfill and fill.

B. Compact planting areas to 90 percent (90%) maximum dry density for soils which exhibit a well-defined moisture density relationship determined in accordance with ASTM D-1557.

3.10 FINE GRADING

A. General: Uniformly grade planting areas to a smooth surface, free from 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. Slope grades to direct water away from buildings and to prevent ponding.

3.11 PROTECTION

A. When required, erect temporary signs and barriers to protect work area.

3.12 MAINTENANCE

A. Immediately before establishment of planting material, regrade areas which become eroded, settled or otherwise disturbed.

B. Perform all maintenance work in accordance with the Specifications without additional compensation.

C. Maintenance period to extend until installation of planting material.

3.13 CLEANING

A. Immediately clean spills, soil, and conditioners on paved and finished areas.

B. Haul and dispose of materials in excess of the quantity required for the project off site.

C. Dispose of protective barricades and warning signs at termination of maintenance period.

END OF SECTION

SECTION 329200
TURF AND GRASSESS

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. Sodding lawn areas as shown on drawings.

B. Related Sections:
1. Division 32 Section - Topsoiling
2. Division 32 Section - Planting

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

1.4 SUBMITTALS

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

B. Certification of Grass Sod: From sod vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of cutting.

C. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer.

D. Qualification Data: For landscape Installer.

E. Planting Schedule: Indicating anticipated planting dates for each type of planting.

F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of lawns until acceptance of substantial completion.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced English speaking full-time supervisor on Project site when planting is in progress.

B. Topsoil Analysis: See Division 02 Section “Topsoil” for requirements regarding topsoil testing and analysis. Additionally, for topsoil intended for lawn areas:

1. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.

C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Sod: Per industry standards for delivery and storage.

1.7 SCHEDULING

A. Planting Restrictions: Permanent lawn plantings must occur during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion. For temporary seeding outside of the permanent planting periods, see Division 32 on Earthwork about Erosion Control.

Sodding:

1. Spring Planting: April 1- May 31 – confirm 3 consecutive days of soil temperatures between 50 and 65 degree Fahrenheit.
2. Fall Planting: August 15 – October 15

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.8 LAWN MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:

1. Seeded Lawns: 60 days from date of Final Acceptance.

B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.

1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.

C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches (100 mm).

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water lawn at a minimum rate of 1 inch (25 mm) per week.

D. Mow lawn as soon as top growth exceeds 3”. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule subsequent mowings to maintain the following grass height:

1. Mow grass 2 to 3 inches (50 to 75 mm) high.

E. Lawn Post-fertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) to lawn area.

PART 2 - PRODUCTS

2.1 SOD

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 95 percent pure seed, and not more than .5 percent weed seed:
1. Sun and Partial Shade: Proportioned by weight as follows:
   a. 50 percent Tall Fescue: (*Festuca arundinacea*), a minimum of three cultivars.
   b. 30 percent chewings red fescue (*Festuca rubra* variety).
   c. 10 percent perennial ryegrass (*Lolium perenne*).
   d. 10 percent redtop (*Agrostis alba*).

2.2 TOPSOIL, SOIL AMENDMENTS

A. Refer to Division 32 Section “Topsoiling”

2.3 PLANTING ACCESSORIES

A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.4 FERTILIZER

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.5 MULCHES

A. Salt-Marsh Hay: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

   1. Organic Matter Content: 50 percent of dry weight.

C. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

D. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.6 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.

B. Erosion-Control Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

B. 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.

3.3 LAWN RENOVATION

A. Renovate existing lawns damaged during construction.

B. Renovate any existing lawn damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish lawn where settlement or washouts occur or where minor regrading is required.

C. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury in soil.

D. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new topsoil.

E. Mow, dethatch, core aerate, and rake existing lawn.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

I. Apply soil amendments and initial fertilizers required for establishing new lawns and mix thoroughly into top 6 inches of existing soil. Provide new planting soil to fill low spots and meet finish grades.

J. Apply seed and protect with straw mulch or sod as required for new lawns.

K. Water newly planted areas and keep moist until new lawn is established.

3.4 SATISFACTORY LAWNS

A. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

B. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.5 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.

C. Remove erosion-control measures and barricades after grass establishment period.

END OF SECTION

SECTION 32 93 00

PLANTING

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. Furnish all labor, materials, equipment, and supplies and perform all operations required to complete landscaping work as shown on the drawings and hereinafter specified.
2. Excavation of tree pits and planting beds to the required depth. Backfill & disposal of all excavated materials as required.
3. Furnishing and planting of all plants, including woody and herbaceous plants.
4. Installing, watering, staking, guying, and pruning (if directed) all plants until acceptance by Owner.
5. Furnishing and placing of mulch.
6. Maintaining all installed plantings, including watering, until acceptance of the completed work under this Section.
7. Guaranteeing and replacing of sickly, dying and dead plants through a period of one (1) year following acceptance of the completed work under this Section.
8. Protecting all existing site features from damage during the work of this Section.
9. Maintaining a clean work site throughout duration of planting operations. Clean up of site and removal of any debris at completion of work of this Section.

B. Related Sections:

1. Section 329113 – Topsoiling
2. Section 329115 - Amended Soil
3. Section 329200 - Turf and Grasses

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum-laced as recommended by ANSI Z60.1.

C. Bare-Root Stock: Exterior plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for kind and size of exterior plant required.

D. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass

during shipping and be sized according to ANSI Z60.1 for kind, type, and size of exterior plant required.

E. Finish Grade: Elevation of finished surface of planting soil.

F. Planting Soil: See Section 02810 – Amended Planting Soil

G. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

H. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

I. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.

2. Plant Photographs: Submit color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

B. Samples for Verification: For each of the following:

1. Trees and Shrubs: Three Samples of each variety and size delivered to site for review. Maintain approved Samples on-site as a standard for comparison. Where not feasible, Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality.

2. Mulch: 1-quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.

3. Staking and components.

1.5 INFORMATIONAL SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Materials Lists: Within 45 days after award of the Contract, submit a complete list of all materials proposed to be furnished and installed (including sources) under this Section, demonstrating conformance with the requirements specified.

C. Product certificates signed by manufacturers certifying that their products comply with specified requirements.

1. Manufacturer’s certified analysis for standard products.

2. Analysis for other materials by a recognized laboratory made according to methods

established by the Association of Official Analytical Chemists, where applicable.

3. Label data substantiating that plants, trees, and planting materials comply with specified requirements.

D. Qualification data for firms and persons to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Owner's representatives and owners, and other information specified.

E. Submit project schedule for approval by Owner's representative at least five days prior to planned start of work. Schedule must include milestone dates that are coordinated with other site trades and locations of work.

1.6 QUALITY ASSURANCE

A. Codes and Standards: Perform all work in compliance with applicable requirements of governing authorities having jurisdiction.

B. Installer Qualifications: Engage an experienced Installer who has completed landscaping work similar in material, design, and extent to that indicated for this Project and with a record of successful landscape establishment.

C. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site during all times. Provide at least one English speaking person present at all times during execution of this portion of the work, who is thoroughly familiar with the type of plants being installed and the proper materials and methods for their installation, to direct all work performed under this Section. This person shall have a minimum of 5 years experience in handling the specified plants, and should have a set of prints of the project on site.

D. Provide quality, size, genus, species, and variety of plants indicated on the Plans, in accordance with the applicable requirements of ANSI Z60.1 American Standard for Nursery Stock, revised 2014.

E. Measurements: Measure trees according to ANSI Z60.1, revised 2014. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Take caliper measurements 6 inches (150 mm) above ground for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above ground for larger sizes. Measure main body of tree for height and spread; do not measure branches or roots tip-to-tip.

2. Other Plants: Measure with stems and foliage in their normal position.

F. Owner's representative may inspect trees either at place of growth or at site before planting, for compliance with requirements for genus, species, variety, size, and quality. Owner's representative retains the right to further inspect trees for size and condition of balls and root systems, insects, injuries and latent defects, and to reject unsatisfactory or defective material at any time during progress of work. Contractor shall remove rejected trees from project site.

1. Notify Landscape Architect of sources of planting materials seven days in advance of delivery to site.

G. All plants are to be provided as specified. Requests to use plant substitutes, whether for size or species/cultivar, shall be submitted in writing to the Owner's representative for client review and approval, prior to delivery to the job site.

H. Nomenclature will be in accordance with Hortus III.

I. All plants shall comply with State and Federal laws, including quarantines with respect to inspection, plant diseases and insect infestation.

J. Collected plants may be used only when approved by the Owner's Representative.

K. Equipment:

1. Provide machinery and equipment necessary for the prompt, professional completion of the work. Such machinery and equipment shall be adequate to the task required and shall be operated by a person skilled and experienced in both operation of the equipment and the implementation of the task.

2. Upon request, promptly furnish satisfactory evidence of the organization and equipment to be made available for the performance of the work.

3. Comply with all Federal and State Department of Agriculture regulations for pest control which, in general, require that contractors operating in infested areas thoroughly clean all equipment units before moving them to non-infested areas. Full information can be obtained from Federal and State Pest Control Personnel.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery and while stored at site.

B. Trees: Deliver freshly dug trees. Do not prune before delivery, except as approved by Owner's Representative. Protect bark, branches, and root systems from sun scald, desiccation and drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees in such a manner as to destroy natural shape. Provide protective covering during delivery to prevent wind burn.

C. Handle balled and burlapped stock by the root ball only. B and B material will be rejected if dropped.

D. Container Plants: Deliver all plants to site in containers that ensure the protection of entire plant including roots and other plant parts against climatic and other injuries. Plants shall be grown or established in containers in which they will be delivered for at least 8 months but not for more than 24 months in advance of final planting. Plants shall be fully rooted into container but not root-bound. Plants with cracked or broken balls of earth when taken from the containers shall not be planted unless acceptable to the Owner's Representative. Do not lift or handle container plants by tops, stems, or trunks at any time.

E. Deliver plants to site after completion of bed preparation and install immediately. If planting is delayed more than 6 hours after delivery, set planting materials in shade, protect from weather and mechanical damage, and keep roots moist. Properly protect plants with soil, moist mulch, etc., in a manner acceptable to the Owner's Representative. Water heeled in plants daily, in a manner acceptable to Owner's Representative.

1. Set balled stock on ground and cover ball with soil if not installed within six hours from delivery.

2. Do not remove container-grown stock from containers before time of planting.

3. Water root systems of trees stored on site with a fine mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.8 PROJECT CONDITIONS

A. Utilities: Determine location of above grade and underground utilities and perform work in a manner that will avoid damage. Hand excavate, as required. Maintain grade stakes until removal is mutually agreed upon by parties concerned. The Contractor shall be responsible for the location and protection of all utilities and for repair of any utilities damaged by Contractor's work. Any damage shall be replaced/repaired to Owner's satisfaction at the Contractor's expense.

B. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Owner's representative before planting.

C. Work notification: Notify Owner's Representative at least five (5) working days prior to the start of work of this Section.

1.9 COORDINATION AND SCHEDULING

A. Planting Restrictions: Plant during one of the following periods.

1. Deciduous trees and shrubs

a. Spring Planting: 1 March to 31 May.

b. Fall Planting: 15 October to 15 December.

2. Evergreen trees and shrubs (including Boxwood)

a. Spring Planting: 15 March to 31 May.

b. Fall Planting: 1 September to 15 November.

Coordinate planting periods with maintenance periods to provide required maintenance thru date of Substantial Completion.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

C. Project Sequence: Plant trees and shrubs after finish grades are established and before planting lawns.

1. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.

1.10 PLANT MATERIAL QUANTITIES

A. The Planting Schedule, including sizes, quantities, and other requirements are indicated on the Drawings. In the event that quantity discrepancies or material omissions occur in the Plant List, the Planting Plan shall prevail.

1.11 MAINTENANCE

A. Maintain for the following maintenance period by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, tightening and repairing stakes and guy supports, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray as required to keep trees and shrubs free of insects and disease. Revise duration of maintenance period below to suit Project. Revise starting date of maintenance period to date of planting completion if preferred.

B. Maintenance Period: Until date of Final Acceptance, as confirmed in writing by the Owner.

1.12 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 by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Warrant the following living planting materials for a period of one (1) year after the date of Acceptance of Installation, against defects including death and unsatisfactory growth, except for defects resulting from neglect or abuse by Owner, abnormal weather conditions unusual for warranty period, or incidents that are beyond Contractor's control.

   1. Trees and Shrubs
   2. Herbaceous and groundcover plants

C. Replace at the direction of the Owner's Representative and in accordance with the Drawings and Specifications, all plants that are dead (all material that is at least 25% dead, and any tree with a main leader that has died back), plants that are in unhealthy or unsightly condition, plants that have lost their natural shape due to dead branches, or other causes due to the Contractor's negligence.

D. All replacements shall be plants of the same kind, size, and quality as originally specified.

E. Warranty shall not include damage or loss of plants caused by fires, floods, freezing rains, lightning, winds over 75 miles per hour, winter kill caused by severe winter conditions not typical of the planting area, by acts of vandalism, or by negligence on the part of the Owner.

F. Replaced plants shall be furnished, planted, mulched, and watered as part of the warranty.

PART 2 - PRODUCTS

2.1 GENERAL

A. All plants shall be the kind and size indicated on the plant list and shall be true to name. All plants shall be sound, healthy, vigorous, nursery stock with a normal habit of growth, shall be subjected to nursery root and top spraying, transplanting, etc., and shall have been inspected and approved for sale, transporting and transplanting by all governmental agencies authorized to administer such control. Plants shall be subject to inspection and approval by the Owner's Representative at place of growth and upon delivery to project site for conformity to specifications. Such approval shall not impair the right of inspection and rejection during process of the work. All trees will be tagged in the nursery by the Owner's Representative.

B. All plants shall be subject to inspection and approval by the Owner's Representative throughout Contract period. The Contractor must submit to the Owner's Representative a letter of certification from the supplying nurseries that plants supplied to the contractor conform to the requirements listed below:

   1. Provide trees of sizes and grades conforming to ANSI Z60.1 for type of trees required. Trees of a larger size may be used if acceptable to Owner's representative with a proportionate increase in size of roots or balls, and at no additions to the Contract Price.

C. Prior to delivery to the site, the Contractor shall arrange with the Owner's Representative a minimum of two nursery visits for the purpose of selecting and tagging plants proposed for the project. This will include all trees as specified. The Owner's Representative shall inspect proposed plants before plants will be permitted on site.

D. Label at least one (1) tree of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.

2.2 SHADE AND FLOWERING TREES

A. Shade trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, free of branches to about 50% of their height, of height and caliper indicated, conforming to ANSI A300 Section 6 for type of trees required.

B. Provide balled and burlapped trees except where indicated.

1. Container-grown trees will be accepted in lieu of balled and burlapped trees subject to meeting ANSI A300 Section 6 limitations for container stock.

2.3 DECIDUOUS SHRUBS

A. Form and Size: Deciduous shrubs with not less than the minimum number of canes required by and measured according ANSI A300 Section 6 for type, shape, and height of shrub.

2.4 CONIFEROUS EVERGREENS

A. Form and Size: Normal-quality, well-balanced, coniferous evergreens, of type, height, spread, and shape required, complying with ANSI A300 Section 6.

B. Form and Size: Specimen-quality, exceptionally heavy, tightly knit, symmetrically shaped coniferous evergreens:

1. Provide balled and burlapped trees.

2.5 BROADLEAF EVERGREENS

A. Form and Size: Normal-quality, well-balanced, broadleaf evergreens, of type, height, spread, and shape required, complying with ANSI A300 Section 6.

1. Provide balled and burlapped or container plants as per plant schedule.

2.6 GROUNDCOVER PLANTS

A. Groundcover: Provide groundcover of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1.

2.7 HERBACEOUS PLANTS

A. Annuals: Provide healthy, disease-free plants of species and variety shown or listed. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but not yet in bloom.

B. Perennials: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed.

C. Vines: Provide vines of species indicated complying with requirements in ANSI Z60.1 as follows:

1 Two-year or older plants with heavy, well-branched tops, with not less than 3 runners 18 inches or more in length, and with a vigorous well-developed root system.

2 Provide field-grown vines. Vines grown in pots or other containers of adequate size and acclimated to outside conditions will also be acceptable.

2.8 REQUIREMENTS FOR BALLED AND BURLAPPED STOCK

A. Where indicated to be balled and burlapped, provide trees dug with firm, natural ball of earth in which they are grown free of noxious weed matter.

B. Provide ball size of not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree required. Increase ball size or modify ratio of depth to diameter as required to encompass fibrous and feeding root system necessary for full recovery of trees subject to unusual or non-typical conditions of growth, soil conditions or horticultural practice.

C. No balled and burlapped plant will be accepted if the ball is cracked or broken either before or during the process of planting.

D. Wrap and tie earth ball as recommended by ANSI Z60.1 for size of balls required. Drum-lace balls with a diameter of 30" or greater.

2.9 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Triple shredded hardwood mulch.
2. Size Range: 3 inches maximum, 1/2 inch minimum.
3. Color: Dark brown, not dyed.

2.10 LANDSCAPE HAND EDGING

A. Planting beds and tree rings are to be vertically edged with a hand spade or mechanical edger to a minimum depth of 4”. The elevation of the planting bed starts at the low point of the cut edge and angles back towards the planting at a 45 degree angle until it reaches the finish grade of the planting bed. Work excess soil back into planting bed.

2.11 TOPSOIL

A. See Section 02800 - Topsoiling

2.12 SOIL AMENDMENTS:

A. Fertilizer: “dryROOTS2” root growth enhancer and soil conditioner or approved equal. Apply to soil surface at manufacturer’s recommended rates after planting.

2.13 ANTI-TRANSPIRANT:

A. Shall be "Wilt-Pruf" by Nursery Specialty Products, Inc., 207 East 47th Street, New York, NY 10017, or approved equal, applied as specified by the manufacturer to species as indicated in drawings.

2.14 PLANTING SOIL

A. See Section 02810 Amended Planting Soil

2.15 EROSION-CONTROL MATERIALS

B. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.

C. Erosion-Control Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive landscaping for compliance with requirements and for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Verify that planters have been waterproofed and inspected.

C. Verify the required drainage and irrigation rough-in has been installed and is fully operational.

D. Verify that subgrades are accurately established before spreading planting soil.

E. Once bed preparation has been approved, the Landscape Contractor assumes responsibility for subgrades and finish grades in the areas affected.

3.2 LAYOUT

A. General: The Planting Plan identifies locations for all planting material.

B. Trees: The locations of trees shall be identified by the Contractor using flagged stakes. Owner's Representative shall approve all locations prior to commencement of work.

C. When the Owner's Representative is satisfied with the locations of all trees and groundcovers, the Contractor shall be instructed to proceed with planting. This approval may be given on a zone by zone basis.

3.3 EXCAVATION FOR TREES & SHRUBS

A. Pits and Trenches: Excavate with vertical sides. Maintain undisturbed subgrade at bottom of pit. In no case shall the distance from the ball to the side of the pit be less than eighteen (18) inches.

B. Trees with a ball of earth less than four (4) feet in diameter shall be planted in a pit three (3) times as wide as the diameter of the root ball.

C. No plant pits shall be dug until the proposed locations have been staked on the ground by the Contractor and approved by the Owner's Representative.

D. Where, in the opinion of the Owner's Representative, the subgrade material is unsuitable, the size of the plant pits shall be dug one-half (1/2) wider and one-third (1/3) shallower than normally required. The ball shall be set 1/3 out of the ground and planting soil shall be mounded around the top of the ball. Planting pits shall be backfilled with amended planting soil, see Section 02810.

E. Obstructions: Notify Owner's representative if unexpected rock or obstructions detrimental to trees are encountered in excavations.

F. Drainage: Notify Owner's representative if subsoil conditions evidence unexpected water seepage or retention in tree pits.

3.4 PLANTING TREES & SHRUBS

A. Set balled and burlapped stock plumb and in center of pit or trench with top of ball raised above adjacent finish grades as indicated:

1. Place stock on cultivated subgrade. Place all trees at a level so that the tree flare is exposed and top of ball is 2 inches above final grade, do not cover top of root ball with soil.

2. Cut and remove twine from collar of tree. Cut off and remove top 1/3 of wire baskets, fold back. Cut off and remove burlap at same level from balls and from sides, but do not remove from under balls. If there is no wire basket, cut and remove twine and burlap from top 1/3 of root ball. Plants with synthetic burlap and twine, or burlap treated with

root growth inhibitors, will not be accepted unless all materials are cut and removed completely. Remove pallets, if any, before setting.

3. Place soil around ball in layers, tamping to settle backfill and eliminate voids and air pockets. When pit is approximately half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing and tamping final layer of backfill.
4. At the time of planting, provide 3 inches high continuous soil saucer around perimeter of planting hole. Prior to end of guarantee period, but not sooner than 8 months after planting, contractor is required to shave off the saucer around the mulch ring area and top dress with new mulch.
5. Cover exposed earth with no more than 3 inches deep (mulch).
6. Stake trees as shown on drawings.

B. Set container-grown stock plumb and in center of pit or trench with top of ball raised above adjacent finish grades as indicated.

1. Carefully remove entire container so as not to damage roots.
2. All rootballs removed from container should be scarified and roots thoroughly separated prior to planting.
3. Place stock on cultivated subgrade.
4. Place soil around ball in layers, tamping to settle backfill and eliminate voids and air pockets. When pit is approximately half backfilled, water thoroughly before placing remainder of backfill.

C. “dryROOTS2” Application: Apply on top of backfill/bed area after planting at specified rates and water in.

D. Apply Anti-Transpirant to all evergreen trees and broadleaf evergreen shrubs per manufacturer specifications.

3.5 PLANT PRUNING

A. Prune, thin, and shape trees according to standard horticultural practice and as directed by owner’s representative. Prune trees to retain required height and spread. Unless otherwise directed by Owner’s Representative, do not cut tree leaders; remove only crossing, injured or dead branches.

3.8 GROUNDCOVER, PERENNIAL, ANNUAL, AND VINES PLANTING

A. Set out and space groundcover and plants as indicated.

B. Dig holes large enough to allow spreading of roots, and backfill with planting soil.

C. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

D. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

3.9 CLEANUP, PROTECTION AND MAINTENANCE

A. During landscaping, keep pavements clean and work area in an orderly condition.

B. Protect landscaping from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods.

Treat, repair, or replace damaged landscape work as directed.

C. Maintain trees by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, tightening and repairing stakes and guy supports, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray as required to keep trees free of insects and disease. Maintain trees for the following period. Maintain trees until condition is approved by Owner's Representative and Owner, and Owner has reviewed and accepted maintenance instructions provided by the Contractor. All plantings which appear to be in distress shall be replaced or replanted as directed by the Owner's Representative.

D. During the first summer, trees should be equipped with Gator bags or should have the trunk surrounded with rings made out of perforated soaker hose, connected through a timer to a water supply. It is contractor's duty to keep this system operating over the summer

3.10 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of it off the Owner's property.

3.11 INSPECTION AND PROVISIONAL ACCEPTANCE:

A. The Contractor may request inspection for provisional acceptance sixty (60) days after completing all planting. Upon completion of all repairs of renewals which the Commissioner deems necessary at this inspection, provisional acceptance shall be certified in writing by the Owner's Representative

3.12 GUARANTEE

A. The Contractor's guarantee for the landscaping work shall extend for one (1) year from the date of provisional acceptance (end of construction) of the work and shall extend through the date of final acceptance (end of guarantee period). All plants must be in a vigorous growing condition at the end of the guarantee period. Defective materials, as determined by the Owner's Representative, shall be replaced immediately with specimens of the same species and size as the original and shall be in place prior to final acceptance.

END OF SECTION

SECTION 33 10 00

WATER UTILITIES

PART 1 - GENERAL

1.01 SUMMARY

The Contractor shall furnish and install all water mains, valves, hydrants, fittings, corporation stops, building service piping and appurtenances as specified herein and as defined on the drawings or as directed by the Engineer in accordance with the City of Lewes Standard Specifications. Provide all necessary adaptors for connection to existing mains. The contractor is given the option of using ductile iron or PVC pipe under this contract. PVC pipe shall not be permitted for hydrant leads, Fire Department connection mains, and services from the tee at the main to the building.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Shop Drawings: Submit shop drawings indicating material characteristics, details of construction, connections, and relationship with adjacent construction.

1.03 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

B. Testing: Hydrostatic tests at minimum 1-1/2 times working pressure for 2 hours.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Ductile Iron Pipe 4 Inches and Larger: AWWA C151, Class 50 minimum.

1. Lining: AWWA C104, cement mortar, seal coated.
2. Gaskets: AWWA C111.
3. Ductile Iron and Cast Iron Fittings, AWWA C110 or AWWA C153, 250 psi minimum pressure rating; AWWA C104 cement mortar lining; AWWA C111 rubber gaskets.

B. PVC Pipe 4 Inches and Larger: AWWA C900, Class 150.

1. Gaskets: ASTM F 477, elastomeric seal.
2. PVC Couplings and Fittings: AWWA C900 with ASTM F 477 elastomeric seal gaskets.
3. Ductile Iron and Cast Iron Fittings: AWWA C110, 250 psi pressure rating; AWWA C104 cement mortar lining; AWWA C111 rubber gaskets.

C. Fiberglass Pressure Pipe 2 Inches and Larger: AWWA C950, Type I filament wound or Type II centrifugally cast; Grade 1 or 2; fiberglass fittings, AWWA C950, RTRP, 200 psi minimum pressure rating.

D. Copper Water Tube 2 Inches and Smaller: ASTM B 88, Type K seamless, annealed temper; ANSI B16.22 wrought-copper solder-joint copper fittings.

E. Copper Water Tube 2 Inches and Smaller: ASTM B 88, Type L seamless, annealed temper; ANSI B16.22 wrought-copper solder-joint copper fittings.

F. PVC Pipe 3 Inches and Smaller: ASTM D 1785, Schedule 40; Schedule 40 socket-type PVC fittings or elastomeric gasketed joint.

G. Polybutylene Pipe 3 Inches and Smaller: AWWA C902, DR 17 barbed insert type brass or bronze fittings.

H. Polybutylene Pipe 3 Inches and Smaller: ASTM D 2662, SIDR15 barbed insert type brass or bronze fittings.

I. Polybutylene Tubing 3 Inches and Smaller: ASTM D 2666, SIDR13.5 brass or bronze fittings.

J. Polyethylene Pipe and Tubing 3 Inches and Smaller: AWWA C901; barbed insert type copper alloy or nylon fittings.

K. Couplings: ASTM A 126, gray iron sleeve assembly with followers, rubber gaskets, bolts, nuts, and enamel paint finish.

L. Valves:

1. Nonrising stem gate valves 3 Inches and larger, AWWA C500.
2. Rising stem gate valves 3 Inches and larger, AWWA C500 or AWWA C509.
3. Nonrising stem gate valves 2 inches and smaller, MSS SP-80.
4. Valve Accessories: Cast-iron valve boxes, curb stops, and service boxes for curb stops.
5. Tapping sleeve and tapping valve for new connections larger than 2 inches.
6. Service clamps and corporation stops for new connections 2 inches and smaller.

M. Anchorages:

1. Clamps, Straps, and Washers: ASTM A 506, steel.
2. Rods: ASTM A 575, steel.
3. Rod Couplings: ASTM A 197, malleable iron.
4. Bolts: ASTM A 307, steel.
5. Cast-Iron Washers: ASTM A 126, gray iron.
6. Concrete Reaction Backing: ASTM C 150, Type I Portland cement for 3000 psi, 28 day minimum compressive strength.

N. Yard Hydrants: Post type.

O. Valve Pits and Meter Pits: Reinforced concrete with ladder and cast-iron manhole frame and cover.

P. Water Meter: Utility company water meter.

Q. Meter Box: Cast-iron body and cover with lettering.

R. Identification: Metallic-lined plastic underground warning tapes.

S. Fire Service Main Accessories:

1. Hose House: 16 gauge (.0598 inches) steel with red baked enamel finish, hoses, and nozzles.
2. Alarm Devices: UL 753 and FM approved including water flow indicators, supervisory switches, and pressure switches.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials and systems in proper relation with adjacent construction. Coordinate with work of other sections.

B. Clean and disinfect system. Test for proper operation. Backfill and protect work from damage.

END OF SECTION

SECTION 33 30 00

SANITARY SEWERAGE SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Provide sanitary sewerage system.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Shop Drawings: Submit shop drawings indicating material characteristics, details of construction, connections, and relationship with adjacent construction.

1.03 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Pipe and Fittings:

1. Hub and Spigot Cast-Iron Soil Pipe and Fittings: ASTM A 74, grey cast iron for compression gasket joints, class of service as required.
2. Hubless Cast-Iron Soil Pipe and Fittings: CISPI 301 grey cast iron for coupling joints.
3. Ductile Iron Pressure Pipe: AWWA C151, Class 150 for push-on joints.
4. Stainless Steel drainage Pipe and Fittings: ASTM A 240, Type 304, stainless steel, gasket joints.
5. Corrugated Steel Pipe: ASTM A 760, Type 1, made from ASTM A 444 zinc-coated steel sheet for banded joints.
6. Corrugated Aluminum Pipe: ASTM B 745, Type 1, made from ASTM A 744 aluminum-alloy sheet for banded joints.
7. Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings: ASTM D 2751, for solvent-cemented or gasketed joints.
8. Corrugated Polyethylene (PE) Drainage Tubing and Fittings: AASHTO M 252 Interim, Type S, with smooth waterway for coupling joints.
9. Corrugated Polyethylene (PE) Plastic Pipe and Fittings: AASHTO M 294 Interim, Type S, with smooth waterway for coupling joints.
10. Corrugated Polyethylene (PE) Plastic Pipe: AASHTO M 294 Interim, Type S, with smooth waterway for gasketed joints.
11. Polyvinyl Chloride (PVC), Cellular-Core Plastic Pipe: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness, for solvent-cemented joints.

12. Polyvinyl Chloride (PVC), Sewer Pipe and Fittings: ASTM D 3034, SDR 35, for solvent-cemented or gasketed joints.
13. Polyvinyl Chloride (PVC), Sewer Pipe and Fittings: ASTM F 679, T-1 wall thickness, bell and spigot for gasketed joints.
14. Polyvinyl Chloride (PVC), Profile, Gravity Sewer Pipe and Fittings: ASTM F 794, open and closed profile, bell and spigot for gasketed joints.
15. Polyvinyl Chloride (PVC), Ribbed Drain Pipe: AASHTO M 304M, bell and spigot, with smooth waterway for bell-gasketed joints.
16. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM C 14, Class 2, for gasketed joints.
17. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76, Class III, Wall B, for gasketed joints.
18. Reinforced-Concrete Arch Pipe: ASTM C 506, Class IV, for banded joints.
19. Reinforced-Concrete Elliptical Pipe: ASTM C 507, Class IV, for banded joints.
20. Cast and Ductile-Iron Pipe Encasement: AWWA C105, polyethylene film tube.
21. Couplings: Rubber or elastomeric sleeve and stainless steel band.
22. Couplings: Rubber or elastomeric compression gasket.
23. Gaskets: Compatible with pipe materials joined.

B. Manholes:

1. Precast Concrete Manholes: ASTM C 478.
2. Manhole Steps: Ductile iron or cast aluminum.
3. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, heavy-duty ductile iron with lettering.

C. Cleanouts:

1. Cast-iron.
2. PVC with cast-iron adapter.

D. Catch Basins for Storm Sewerage System:

1. Precast Concrete Catch Basins: ASTM C 478 or ASTM C 858.
2. Cast-In-Place Concrete Catch Basins: 3000 psi.
3. Catch Basin Steps: Ductile iron or cast aluminum.
4. Catch Basin Frames and Grates: ASTM A 536, Grade 60-40-18, heavy-duty ductile iron.
5. Curb Inlets: Precast concrete, stone, or brick conforming to utility standards.

E. Outfalls for Storm Sewerage System: Cast-in-place reinforced concrete pipe, head wall apron, tapered sides, and rip rap.

F. Trench Drains for Storm Sewerage System: Interlocking precast polymer concrete modular units with grates, channel caps, and related accessories.

G. Identification: Metallic-core plastic underground warning tapes.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials and systems in proper relation with adjacent construction. Coordinate with work of other sections.

B. Where connections are made to existing systems, rout out old drainage lines.

C. Test for proper operation. Clean and protect work from damage.

END OF SECTION

SECTION 33 40 00

STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section covers storm drain pipe and appurtenances.

B. The Contractor shall furnish all labor, materials, and appurtenances necessary to complete all storm drain construction shown on the drawings.

PART 2 - PRODUCTS

2.1 REINFORCED CONCRETE PIPE

A. Reinforced concrete materials used for precast pipe shall conform to Section 32 11 36, "Concrete Base Courses" and shall have a minimum compressive strength of 4000 psi after 28 days of placement.

B. Reinforced concrete pipe shall be manufactured without lifting holes and shall be handled at all times by means of slings or other methods approved prior to start of construction.

C. Reinforced concrete pipe shall meet the applicable strength requirements contained in ASTM Designation: C-76, Reinforced Concrete Culvert, Storm Drain and Sewer Pipe, minimum circumferential reinforcement shall be as prescribed for Class IV.

2.2 MASONRY MATERIALS

A. Mortar for pipe joints and connections to other drainage structures shall be composed of 1 part by volume Portland cement and 2 parts sand. Portland cement shall conform to ASTM C150. Sand shall conform to ASTM C144. Hydrated lime may be added to the mixture of mortar in an amount of not more than 20 percent of the volume of cement. Hydrated lime shall conform to ASTM C141.

2.3 CONCRETE PIPE JOINTS

A. Concrete pipe joints shall be cement mortar bell-and-spigot-joints. The first pipe shall be bedded to the established gradeline, with the bell end placed upstream. The interior surface of the bell shall be cleaned with a wet brush and the lower portion of the bell filled with mortar to such a depth as to bring the inner surfaces of the abutting pipes flush and even. The spigot end of each subsequent pipe shall be cleaned and uniformly matched into the bell so the sections are closely fitted. After each section is laid, the remainder of the joint shall be filled with mortar and a bead formed around the outside of the joint with additional mortar. The cement mortar, finish, and protection of joints shall be as specified. If the mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint shall be wrapped with cheesecloth to hold the mortar in place.

2.4 BACKFILL MATERIALS

A. Backfill materials shall conform to Section 31 23 00, "Excavation for Pipelines and Structures".

2.5 CASTINGS

A. Frames and covers for junction box shall be set by the Contractor as the work progresses. The frame shall be well bedded in mortar.

B. Materials for frames and covers shall be in accordance with the standard specifications for gray iron castings ASTM Designation A-48 for Class No. 35.

C. All frames and covers shall be of the sizes and types detailed on the plans.

D. Inlet gratings shall conform with the detail shown on the plans and/or for the Delaware Department of Highways and Transportation Standard Specifications and Standard Details.

PART 3 – EXECUTION

3.1 EXCAVATION AND BACKFILL

A. Excavation and backfill shall be in accordance with Section 31 23 00, "Excavation for Pipelines and Structures."

3.2 MATERIAL STORAGE

A. Materials required in the work shall be located and retained a sufficient distance from the edge of excavations to prevent such material falling or sliding into the excavations and to prevent cave-ins.

3.3 PIPE INSTALLATION

A. Installation of pipe materials shall conform to the written or published instructions of the manufacturer, except as otherwise specified. The manufacturer's written or published instructions shall supersede referenced national association or trade standard installation practices such as ASTM C12, for the specified material. Where the Contractor proposes to deviate from specified instructions, the proposed deviation shall be submitted for approval.

B. Under no circumstances shall pipe be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Laid pipe shall be inspected before backfilling is initiated.

C. Pipe shall be visually inspected for apparent defects and tapped with a hammer to audibly detect hidden defects, prior to being lowered into a trench.

D. Defective materials found shall be distinctly marked using a road-traffic-quality yellow paint and promptly removed from the site.

E. Pipe shall be laid beginning at a low point of a system and, when in final acceptance position, shall be true to the grades and alignment indicated, with unbroken continuity of invert.

F. Type RCP shall be installed in accordance with the applicable recommendations of ACPA, "Concrete Pipe Installation Manual," except as otherwise specified.

G. Pipe and fittings shall be clean and dry when laid.

H. Pipe, when ready for specified acceptance testing, shall be "broom clean."

I. Interior of line shall be cleared of dirt and superfluous matter as the work progresses. A swab or drag shall be kept in the line and pulled forward past each joint immediately upon completion of the joint. In lines where man entry is possible, brushes and brooms may be used for cleaning. Plugs shall be placed in the ends of uncompleted work at the end of the day and whenever work stops. Plugs shall be commercially manufactured products, unless otherwise approved.

J. Pipe shall be checked to determine whether line displacement or other defects have occurred. Inspection shall take place when 2 feet of earth cover is in place and upon completion of project. A flashlight or mirror-reflected sunlight shall be flashed between manholes. If the illuminated interior indicates poor alignment, debris, displaced pipe infiltration, or other defects, the defects designated shall be remedied by the Contractor.

3.4 BACKFILLING

Backfilling shall conform to Section 31 23 00, "Excavation and Backfill for Pipelines and Structures."

3.5 GRADING

Grading shall conform to Section 31 00 00, "Earthwork".

3.6 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Excess excavated material, trash, debris, and waste materials shall be removed from the project site and legally disposed at no additional cost to the Owner. Permits and fees for disposal shall be paid by the Contractor.

END OF SECTION