Project Manual

Bid Documents

CSD Two Interconnected Middle Schools

Dover, Delaware

Volume IV

BECKER MORGAN GROUP, INC.

ARCHITECTURE
ENGINEERING

Capital School District

2019180.00
November 25, 2020

DOCUMENT 000101 - PROJECT TITLE PAGE

1.1 PROJECT MANUAL VOLUMES IV

A. CSD Two Interconnected Middle Schools.

B. Capital School District.

C. Dover, DE.

D. Owner Project No. CSD 20-001.

E. Architect Project No. 2019180.00.

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L. Issued: November 25, 2020.

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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. Sleeve seals.
4. Foam duct sealant.
5. Grout.
6. Plywood backboards.
7. Protective wire guards.
8. 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. UTILITY COMPANY COORDINATION

A. The Engineer has made the initial service application to the City of Dover electric department for the purposes of obtaining a new electric service. The utility company's contact person is Aren Wright, awright@dover.de.us, (302) 736-7070. After notice to proceed, the Contractor is responsible for all communication, scheduling, site meetings, and follow up with the utility company necessary for the installation of said utility in a timely manner, so service is active and available when needed for start-up, testing, and operation of all equipment and systems prior to substantial completion. Utility fees are to be paid directly by the Owner.

B. Contact and coordinate service entrance equipment and layout with local power company prior to ordering or installing any service entrance equipment. Contractor shall furnish and install all incoming raceway and service entrance cables. If the power company plans to install cable and/or conduit, Contractor is responsible for proper coordination of cable, conduit, lug sizes, etc., for proper interface between utility owned/installed equipment and Contractor-installed equipment.

C. The Owner shall make the application for electrical service and pay for all service charges, as coordinated with the Contractor.

1.7. EXAMINATION OF SITE

A. Examine the site, determine 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.

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.

1.8. 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. switchboards, 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 as generally 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, devices, prior 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.

1.9. 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.

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.

1.10. 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 interlocked 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, whirlpools, 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. in cabinets and 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 with approved casework shop drawings to avoid conflicts with sinks and other appurtenances.

c. Classroom and Lab Equipment
   i. Includes, but is not limited to television mounting brackets, projection screens, exhaust/fume hoods, goggle cabinets, chemical storage cabinets, outlets in lab benches, 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, dumbwaiters, wheelchair lifts, etc.

e. Display Cases
   i. Provide power circuit to display case lighting fixture(s) furnished with display cases under Architectural division. Coordinate voltage with equipment supplier/installer.

f. 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.
   iii. Coordinate mounting height and location of power-assist door operator paddle stations with Architect to ensure ADA compliance.
   iv. Coordinate mounting height and location of raise/lower switches for overhead coiling doors/grilles with Architect.

g. 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.

h. Glazing Systems

i. Includes but is not limited to commercial storefront, curtain wall, 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.

i. Gymnasium Equipment

i. Includes, but is not limited to electrically operated bleachers, basketball backstops, scoreboards, shot timers, divider curtains, etc.

ii. Verify voltage, overcurrent protection and control requirements with approved shop drawings.

iii. Coordinate receptacle configurations for all equipment furnished with cord-and-plug assemblies.

iv. Coordinate mounting heights and locations of control devices furnished with equipment, e.g. raise/lower switches, with Architect.

j. Loading Dock Equipment

i. Includes, but is not limited to dock levelers, trash compactors, etc.

k. Signage

i. Includes but is not limited to building signage, monument signage, site signage, etc.

l. Stage Equipment

i. Includes but is not limited to curtains, rigging, projectors, projection screens, etc.

ii. Coordinate mounting heights and locations of control devices furnished with equipment, e.g. raise/lower switches, with Architect.

m. Window Shades

i. Verify voltage, overcurrent protection, and control requirements with equipment supplier/installer.

ii. Coordinate mounting heights and locations of raise/lower switches with Architect.

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.
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. Lawn Irrigation System(s)
b. Site Signage
c. 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 cabin vending machines, cash registers, microwaves, dishwashers, garbag disposals, ranges, mixers, kettles, convection ovens, utility distri ion systems, etc.
      ii. Verify equipment nameplates and connection require ats p rough-in.
      iii. Coordinate mounting heights and locations of outl boxes erving appliances with approved appliance product da d appr d casework shop drawings where applicable.
   b. Kitchen Fire Suppression Systems
      i. Provide pathway(s) between kitchen fire su ession ystem(s) and fire alarm system.
      ii. Provide connection(s) betwee itchen suppression system(s) and shunt-trip mechanisms on ci t breaker serving equipment located beneath kitchen ventilati hoo such hat upon activation of fire suppression system, shunt ms energize and open circuit breakers, de-energi equip t located beneath ventilation hoods.
   c. Kitchen Ventilation Hood
      i. Provide shun ip m nar ms for circuit breakers serving kitchen equipment loca eneath itchen ventilation hoods. Connect shunt-trip mechanisms to sh fire suppression system as described above.

D. HVAC Equipment and Syste

1. In general, any tri y o ated or controlled equipment furnished under HVAC divisions shall be su ed with control wiring, transformers, contacts, etc.
2. Division shall rovi ower circuits to such equipment and a disconnecting means for each p ce of equ ment, as well as all electrical control equipment and wiring related thereto.
3. rtain chani units are furnished from the factory with motor starters, contactors, transforme uses, wiring, etc., required for fans, pumps, etc. When this equipment is sup ed from the factory, Division 26 shall coordinate with Division 23 such that only one of starters, fuses, switches, etc. is provided.
4. e 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.

   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. Air Handling Units
   b. ATC Panels
   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 Engineer in writing.

g. Electric Unit Heaters
h. Energy Recovery Ventilators
i. Exhaust Fans
j. Fan Coil Units
k. Ground Loop Pumps
l. Heat Pumps
m. Make-up Air Units
n. Outside Air Units
o. Radiant Heat Panels
p. Ventilation Fans

7. To ensure proper electrical coordination between the electrical components supplied under Division 26 and the equipment supplied under Division 23, schedules 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, whirlpools, 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 by 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 Heaters
    b. Electric Water Coolers
        i. Coordinate mounting height and location of receptacle outlets serving electric water coolers with approved shop drawings.
    c. Floor Drains
        i. Coordinate routing of conduit and raceways in floor slabs with floor drains.
    d. Condensate Pumps
        i. Coordinate connection type (i.e. switch or cord-and-plug) with approved shop drawings.
    e. Flush Valves
        i. Coordinate mounting height and location of outlet boxes serving electronic flush valves with approved shop drawings and Division 22.
    f. Gas-Fired Water Heaters
        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.
    g. [illegible]
    h. 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 in writing.
    j. Recirculation Pumps
    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.
    k. 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.
    l. Trap Priming Stations

1.11. 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.

1.12. 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.

1.13. SUBMITTALS

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

1.14. SUBMITTAL PROCEDURES

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

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, operating 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 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.

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. Analysis & Coordination Study
3. Arc Flash Hazard Analysis
4. Arc Flash Hazard Labels
5. Ballasts for Lighting Fixtures
6. Battery Packs for Lighting Fixtures
7. Circuit Breakers
8. Conductors and Cables - 600V or Less
9. Conduit and Raceway
10. Connectors and Splices
11. Disconnect (Safety) Switches
12. Electrical Connection Coordination Schedule
13. Electricity Meters
14. Elevator Control Switches
15. Emergency Off Push-Buttons
16. Emergency Transfer Relays
17. Enclosed Circuit Breakers
18. Equipment Nameplates/Labels
19. Firestopping Materials
20. Foam Duct Sealant
21. Fuses, 600V or Less
22. Generator
23. Ground Busbars
24. Ground Conductors
25. Ground Rods
26. Grout
27. Handholes
28. Hangers and Supp[illegible]s
29. Identification Produ[illegible]
30. Installati[illegible]matic[illegible]Drawings
31. Install[illegible]Certifica[illegible]
32. Junctio[illegible]and Pull B[illegible]xes
33. L[illegible]mps
34. Lighting C[illegible]ations
35. Lig[illegible]ng Control System
36. [illegible]hting Fixtures, Exterior
37. [illegible]hting Fixtures, Interior
38. Lig[illegible]ng Fixtures, TV Studio
39. Lightning Protection System
40. Medium Voltage Cable Termination & Splice Kits
41. Medium Voltage Cables
42. Medium Voltage Grounding
43. Motor Controllers
44. Operation and Maintenance Manual
45. Outlet and Device Boxes
46. Panelboard Circuit Directories
47. Panelboards
48. Qualification Data
49. Receptacles
50. Record Drawings
51. Retractable Cord Reels
52. Roof Penetration Boots /Curbs
53. Sleeves
54. Sleeve Seals

55. Surge Protective Devices
56. Switchboards
57. Testing Agency Qualifications
58. Test Reports
59. Toggle/Snap Switches
60. Transfer Switches
61. Transformers, 600V and Less
62. Underground Ductbank Products
63. Weatherproof Boxes and Covers
64. 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.

1.15. SHOP DRAWINGS

A. Prepare and submit Shop Drawings for new 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 use 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. Lighting Control System
2. Lightning Protection System
3. Occupancy Sensor Layout

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 original submission to verify compliance.

1.16. 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, hung ceilings, embedded in construction, or in 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.

1.17. 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., i[nto] record drawings prior to delivering the same to the Architect.

1.18. WARRANTY

A. Contractor's attention is directed to warranty obligations contained in the General [Co]nditi[ons]

B. The above shall not in any way void or abrogate equipment manufac[turer]'s gua[rantee] or warranty. Certificates of equipment manufacturer's warranties shall be in[clu]ded in th[e] operations and maintenance manuals.

C. The Contractor guarantees for a two (2) year period from t[he] time of f[inal] acceptance by the Owner:

1. That the work contains no faulty or imper[fect] ma[teri]al or equipment or any imperfect, careless, or unskilled workmanship.
2. That all work, equipment, machines, [dev]ices, et[c.] shall be adequate for the use to which they are intended, and shall opera[te] with [ord]inary c[ar]e and attention in a satisfactory and efficient manner.
3. That the Contractor will re-execu[te], [co]rrect, repair, or remove and replace with proper work, without cost to the Owner, any [wo]rk found to be deficient. The Contractor shall also make good all damage[s] caused to their w[or]k or materials in the process of complying with this section.
4. That the entire w[or]k shall [be] water-tight and leak-proof.

1.19. OPERATION AND MA[IN]TENA[NC]E MANUALS

A. The Contractor shall have p[re]pared six (6) hardcopies and one (1) electronic copy of the Operation and Mai[nt]enance (O&M) manual and deliver these copies of the manual to the Owner. The manual shall be as spe[ci]fied herein. The manual must be approved and will not be accepted as final until so stamp[ed].

B. Hard copie[s] of the O&M 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 – Capital School District – New Middle School - 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. Electronic copy(ies) of the manual shall be in searchable PDF format with interactive index tabs.

E. 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 furnish
4. Complete catalog data on each piece of electrical equipment furnished including appro 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 rts list assembly drawing(s).
7. Access panel charts with index illustrating the location and purpose o cess els.
8. Approved Electrical Certificates, including certificate of approva om ctrical inspector.
9. List of extra materials turned over to Owner, with transmitta eceipt s ed b Owner.
10. Sign-in sheets from demonstration and training sessions.
11. Start-up and test reports for equipment.

F. Additional items identified within other Sections of these ecificat s.

G. Submit Operation and Maintenance Manual prior to e ant ated d e of Substantial Completion for Engineer review and approval. Substantial Comple e req at Operation and Maintenance Manuals be reviewed and approved.

1.20. INSTRUCTION

A. Upon completion of all work, th ghly instruct e Owner's representatives in the proper operation and maintenance of all electri al eq oment and systems.

B. Instructions shall be done o er completed systems have been put into operation and tested for proper operation and form

C. Instructions sha be given d y by experts in the equipment or system and shall include descriptions and demonstrat s of proc ures of operation, data record keeping, etc.

D. Furni the nec ssary technicians, skilled workers, and helpers to operate the electrical systems and equi nt o he entire project for one (1) 8-hour day.

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

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

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

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

I. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

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, Food Service, 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 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, w plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than es (0 mm) and no side more than 16 inches (400 mm), thickness sh l be 0.0 inch (1.3 mm).
b. For sleeve cross-section rectangle perimeter equ , or mo than, 50 inches (1270 mm) and 1 or more sides equal to, or more n, 16 ches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2. SLEEVE SEALS

A. Description: Modular sealing device, desig field embly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compli with r uirements, available manufacturers offering products that may be incorporated e Work include, but are not limited to, the following:

a. Advanc roduc Systems, Inc.
b. Bridgepo gs, Inc.
c. C Inc.
d. GS Me Cor ation
e. Metraflex o.
f. O-Z/Ged y
eal and Insulator, Inc.
h. Raco, Inc.

2. aling Elements: EPDM, interlocking links shaped to fit surface of cable or conduit. In de type and number required for material and size of raceway or cable.
3. Pressure Plates: Stainless Steel. Include two (2) for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel, of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3. OUT

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.

2.4. FOAM DUCT SEALANT

A. Description: Two-part, high-expansion foam duct sealant to keep water, acids, dust, gases, insects and rodents out of ducts (conduits).

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

1. American Polywater Corporation

C. Basis of Design: FST Foam Sealant by American Polywater Corporation.

D. The foam duct sealant shall be a two-part "blown" urethane foam with 98% closed cell conte

E. The foam duct sealant shall have a compressive strength of 300 pounds (ASTM D1), a te strength of 250 pounds (ASTM D1623), and a flexural strength of 450 pounds (TM 90).

F. The foam duct sealant shall be compatible with common cable jacket T ured foam shall be an inert solid that does not affect jacket materials.

G. The foam duct sealant shall withstand temperatures from -20 degrees hrenh t to 200 degrees Fahrenheit and shall not lose function in direct sunlight

H. The foam duct sealant shall be chemically resistant to gas oils, di e acids and bases, and most unsaturated hydrocarbons.

I. The foam duct sealant shall foam and react in ten tes at 70 degrees Fahrenheit.

J. When installed, the sealant shall be capab f he ng 5 psi air pressure continuously (equivalent of 16.4 feet water-head pressure).

2.5. BACKBOARDS

A. Backboards: Plywood, A/ e, fire-retardant treated, ¾" x 48" x 96" (19 x 1220 x2440 mm) with no added urea dehy

B. Install each fir etardant-t ted plywood backboard six inches off the floor to bottom. Secure backboard wit minimu of eight (8) screws. Plywood backboards shall have one side with exterior ue and fi ed smooth side. Mark all backboards and cabinets with appropriate lege (e.g., "COMM").

C. Verify local codes or AHJ prior to painting fire-retardant-treated plywood backboard with stamped fi ting 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).

2.6. PROTEC VE WIRE GUARDS/SHIELDS

A. Provide protective guards over devices subject to physical damage. All devices installed in the gymnasium, 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. Thermostats

3. Exit Signs
4. Emergency Lighting Units
5. Wiring Devices
6. Emergency Shut-Off Stations
7. 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 internal 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 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 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 required. Exact requirements for temporary service shall be determined by the Construction Manager.

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. Five (5) 20-ampere circuits 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,	10

AREA	FOOT CANDLE LEVEL
shops, locker and dressing areas	

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, wire connections, etc., for obtaining power from utility company lines.

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 INSTALLATIONS

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

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

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

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

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

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

I. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

J. 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".

K. 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 material. Comply with requirements of Division 07 Section, "Penetration Firestopping" and Division 26 Section "Electrical Firestopping".

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

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and joint sealant. Pro

N. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals. Seal interior of each raceway with foam duct sealant as specified herein.

3.4. SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

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

3.5. FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 26 Section 260528, "Firestopping for Electrical Systems".

3.6. SUPPORTS, HANGERS AND FOUNDATIONS

A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all 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 six inches beyond equipment bases, unless otherwise noted.
2. Provide six (6) inch high concrete foundations (housekeeping pads) for all exterior pad-mounted equipment, extending a minimum of 12 inches beyond equipment bases, unless otherwise noted.
3. Furnish foundations, bolts, sleeves, anchors, 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.
4. Unless otherwise specified, provide all concrete work required in accordance with the requirements of Division 03.
5. 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.
6. Determine the exact location of all equipment, foundations, and supports after Shop Drawings of equipment have been approved.

D. Refer to Division 26 Section 260529, “Hangers and Supports for Electrical Systems” for additional requirements.

3.7. PROVISIONS FOR ACCESS

A. The Contractor shall provide access panels and doors for all concealed equipment, and other devices requiring maintenance, service, adjustment or manual operation.

B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.

1. Acoustical or Cement Plaster: Style B
2. Hard Finish Plaster: Style K or L

3. Masonry or Dry Wall: Style M

C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.

D. Access panels, doors, etc. described herein shall be furnished under the section of Specification 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 if applied 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).

3.8. PAINTING AND FINISHES

A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.

B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.

C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamels 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.

. All exterior equipment and conduits shall be painted to match adjacent surface in color as selected by Architect, unless otherwise indicated by the Architect/Owner.

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.

3.9. COLOR SELECTION

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

3.10. PROTECTION OF WORK

A. Protect work, material and equipment from weather and construction operations before and after

installation. Properly store and handle all materials and equipment.

B. Cover temporary openings in conduits and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver conduits with factory applied end caps.

C. Cover or otherwise protect all finishes.

D. Replace damaged materials, devices, finishes and equipment.

E. Protect stored conduits from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.11. OPERATION OF EQUIPMENT

A. Clean all systems and equipment prior to initial operation for testing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.

B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technicians.

C. Submit factory start-up sheets or field start-up 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.

3.12. TESTING AND ADJUSTMENT

A. Perform all tests which are specified or required to demonstrate that the work is installed and operating properly. Where formal tests are required, give proper notices and perform all necessary preliminary tests to assure that the work is complete and ready for final test.

B. Adjust all systems, equipment and controls to operate in a safe, efficient and stable manner.

C. On all circuits, 600 volts or less, provide circuits that are free from ground faults, short circuits and open circuits.

D. Other tests of a specific nature for special equipment shall be as specified under the respective equipment.

E. Submit all test results to the Architect for approval.

3.13. 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 260528, "Firestopping for Electrical Systems".

C. Where penetrating through exterior walls below grade, provide waterproof sleeve seals, as specified in Part 2 of this Section.

D. Provide conduit escutcheons for all exposed conduit penetrations in finished interior spaces and all exposed exterior penetrations.

E. Conduit sleeves:

1. Galvanized steel pipe, standard weight where pipes are exposed to roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
2. Twenty-two (22) gauge galvanized steel elsewhere.

3.14. EQUIPMENT BY OTHERS

A. This Contractor shall make all system connections required for equipment furnished and installed under other divisions or furnished by the Owner. Connections shall be complete in all respects to render this equipment functional to its fullest intent.

B. It shall be the responsibility of the supplier of the equipment to furnish complete instructions for connections. Failure to do so will not relieve the Contractor of any responsibility for improper equipment operation.

3.15. PHASING

A. Refer to Architectural Specifications and Contract Drawings for any required phasing.

B. Maintain building egress and traffic ways at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and Authorities Having Jurisdiction (AHJ).

C. Provide dust barriers/partitions, penetration closures, etc, to ensure safety of building occupants and protection of existing surroundings.

D. The Building shall remain watertight at all times.

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

3.16. OUTAGES

A. Provide a minimum of 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.

3.17. CUTTING AND PATCHING

A. Accomplish all cutting and patching necessary for the installation of work under Division 26. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike manner. Restore disturbed work to match and blend with existing construction and finish, using materials compatible with the original. Use mechanics skilled in the particular trades required.

B. Do not cut structural members without approval from the Architect or Structural Engineer.

3.18. PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.

B. Where conduits penetrate roofs, flash pipe with Stoneman Stormtite, [illegible]ate 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.

3.19. CONCRETE AND MASONRY WORK

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

B. Concrete shall 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.

3.20. CONNECTIONS AND ALTERATIONS TO EXISTING WORK

A. Unless otherwise noted on the Drawings, where existing electrical work is removed, including hangers, to a point below finished floors or behind finished walls and capped, such point shall be far enough behind finished surfaces to allow for installation of normal thickness of required finish material.

B. Where work specified in Division 26 connects to existing equipment, conduits, etc., Contractor shall perform all necessary alterations, cuttings, fittings, etc., of existing work as may be necessary to make satisfactory connections between new and existing work, and to leave completed work in a finished and workmanlike condition.

C. Where the work specified under Division 26, or under other Divisions, requires relocation of existing equipment, conduit etc., Contractor shall perform all work and make necessary changes to existing work as may be required to leave completed work in a finished and workmanlike condition.

D. Where the relocation of existing equipment is required for access or the installation of new equipment, the Contractor shall temporarily remove and/or relocate and re-install as required to leave the existing and new work in a finished and workmanlike condition.

3.21. COORDINATION

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

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting 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".

3.22. DEMOLITION

A. Unless otherwise noted all existing equipment, conduit, wire, etc., shall remain.

. 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. 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.

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

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

J. 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.

K. 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.

L. Where conduit and wiring are removed, remove all conduit hangers which were supporting the removed conduit. Patch the remaining penetrations voids with like materials and paint to match existing construction.

M. 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.

N. Before demolition begins, and in the presence of the Owners representative, test and note all deficiencies in the 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.

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

P. All devices and equipment designated by the Owner to remain the property of the Owner shall be removed 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.

Q. 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.

R. 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.

S. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

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

3.23. EXCAVATION AND BACKFILLING

A. General:

1. Perform all necessary excavation, or installation of work under Division 26, in whatever materials or conditions encountered, using suitable methods and equipment.
2. Accurately establish required lines and grades and properly locate the work.
3. Determine the locations of all existing utilities before commencing the work.

B. Excavation:

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 similar 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 260500

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 CHA

PART 1 (FOR OWNER'S USE LY):

APPROVED: _____

YES ____ **NO** ___ **BY:** _____ **DATE:** _____

DATE/TIME-AS REQ STED: _____ **OTHER:** _____

OWNER'S PRESEN QUIRED: _____

YES: ___ **O:** ___ **NAME:** _____

POINT OF CO ACT: _____ **PHONE:** _____

SECTION 260510 - 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. Emergency power system connections.
2. 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 Machine Room, from being installed in Elevator Machine Room.

D. Coordinate wire 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 and machine rooms 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.

1.5. SUSTAINABLE DESIGN REQUIREMENTS

A. Refer to Division 01 Section, Sustainable Design Requirements for description of work under this Division affected by sustainable design requirements.

PART 2 - PRODUCTS

2.1. ELEVATOR CONTROL SWITCHES

A. Description: Heavy duty disconnect switches designed for single hydraulic elevator application to interrupt the incoming AC power upon receiving a signal from the fire alarm control panel (FACP).

B. Standard Features:

1. 600VAC, 3-phase fused power switch, ampere rating as indicated on the drawings.
2. 200kA RMS assembly short-circuit current rating.
3. Shunt trip 120VAC.
4. Control power terminal block.
5. Ground lug per National Electrical Code.
6. Class "J" fuse mounting.
7. Key to test switch.
8. Pilot light to indicate "ON", red LED.
9. Mechanically interlocked auxiliary contact for hydraulic elevators with battery backup, rated at 5 amperes, 120VAC.

C. Additional Features:

1. Control power transformer with fuses and blocks. Primary voltage to match voltage of elevator power supply.
2. Fire safety interface relay.
3. Isolated neutral lug.
4. Fire alarm voltage monitoring relay to monitor shunt-trip voltage.

D. Quality Assurance:

1. UL 98 Enclosed and Dead Front Switch
2. NEMA 1, UL 50 listed enclosure

E. Basis of Design: Eaton Corporation Elevator Control ES Switch

PART 3 - EXECUTION

3.1. INSTALLATION

A. Locate all disconnect devices and elevator machine room light switch on lock side of door within elevator machine room. 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 switch to serve elevator cab power (lighting/ventilation), and if required for signal power. Provide elevator control switch as specified herein to serve electrical controller/drive. Provide fuses sized as directed by elevator supplier. Provide in accordance with NEC Articles 620-22 (a), 620-53, and 620-85.1. Disconnect switch shall be lockable in the "open" position and the "closed" position. Provide each disconnect control switch with an equipment nameplate as detailed on the drawings 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.

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

D. Provide 1-inch conduit, with pull strings 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 mechanism in elevator control switch. Connect to heat detectors as required. Provide power to shunt trip unit as required. Shunt per elevator supplier directions.

G. Provide all wiring for and mount exterior alarm bell.

H. Provide lighting fixtures and duplex GFCI receptacle in elevator pit. Provide switch adjacent to access ladder near the pit stairway door, 36-inch above door sill. Provide in accordance with NEC Articles 620-24 and 620-

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

J. Provide elevator machine room lighting and receptacles in accordance with NEC Articles 620-23 and 620- 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.

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.

IRE ALARM PROVISIONS

A. Fire alarm connections for elevators shall be provided by Advantech.

END OF SECTION 260510

SECTION 260511 - COOLER AND FREEZER 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. Cooler and freezer wiring which includes:

1. Power service connections.
2. Lighting connections.
3. Interconnections between remote compressor and refrigerated units.

PART 2 - PRODUCTS

2.1. CONDUIT

A. Refer to Division 26 Section 260533 "Raceways and Boxes for Electrical Systems".

B. In cooler and freezer areas, use PVC coated rigid conduit. Whenever possible, avoid the use of surface wiring and install conduit in space behind or above insulated panels.

C. Provide fiber nipple through wall or ceiling of siding of refrigerated areas.

2.2. OUTLET BOXES

A. Refer to Division 26 Section 260533, "Raceways and Boxes for Electrical Systems".

B. Provide exterior type boxes and covers for all units installed inside coolers and freezers.

PART 3 - EXECUTION

3.1. INSTALLATION

A. Coolers and freezers to be supplied and installed by other trades prewired complete with light fixtures, switch, door heating tape, all tied to central junction box. Provide all conduit and wire associated with refrigeration equipment, defrost heater, blower coil, alarm, door heaters, drain heaters, interlocks, lighting, switches, evaporator, coil fans, compressors, or any other electric devices supplied with the unit.

B. Arrange to have all openings cut and sealed in coolers and freezers to accommodate electrical system

installation by equipment supplier.

C. Install conduit exposed on surface inside coolers and freezers parallel to room lines.

D. Where conduit enters refrigerated areas, install fiber nipple from box outside refrigerated area to surface mounted box inside area. Provide ground conductor through nipple. After conductors are installed, plug both ends of fiber nipple with oakum.

E. Install wiring for blower fans, defrost heaters, lighting, switches, evaporator, coil fan, compressor interlocks, door heaters, drain heaters, alarms, or any other electric devices supplied with the through the top of the cooler freezer from surface-mounted box in space above.

F. Provide spiral heat tape applied to drain line within interior of freezer compartment. Refer to Division 26 Section 260520, “Electrical Heating Cables” for information.

G. Provide electrical conduits run concealed above walk-in ceilings to serve interior lights.

END OF SECTION 260511

SECTION 260512 - 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. Light switch for control of hood lights.
3. Control wiring specifically shown on Electrical and Kitchen Equipment Drawings.

B. All line and disconnect switches, safety cut-outs 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 260519, “Low-Voltage Electrical Power 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 260533, “Raceways and Boxes for Electrical Systems”.

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 260533, “Raceways and Boxes for Electrical Systems”.

B. Provide only rigid steel conduit, zinc-coated, where concealed, and shall provide [illegible] rigid st[illegible] chrome-plated where exposed. All wiring and conduit shall be run concealed where [illegible] possi[illegible]

C. Provide liquid tight flexible metal conduit connections to all direct connected equi[illegible]ent.

2.4. COVER PLATES

A. Refer to Division 26 Section 262726, “Wiring Devices”.

B. Provide brushed stainless steel plates for receptacles loca[illegible]n stainle[illegible] steel backsplash.

C. Provide weatherproof cover plates for all receptacles in [illegible]mp lo[illegible]ons.

2.5. DISCONNECT SWITCHES

A. Refer to Division 26 Section 262816, “Enclose[illegible]tches and Circuit Breakers”.

B. Provide NEMA 4 type for d[illegible]washi[illegible]g equipment.

2.6. CORDS AND CAPS

A. Straight-blade [illegible]tachment [illegible]g: NEMA WD 1.

B. Lockin[illegible]blade Att[illegible]t Plug: Match receptacle configuration at outlet provided for equipment.

C. Cord [illegible]s[illegible]action: Oil-resistant thermoset insulated Type SO multiconductor flexible cord with identifie[illegible]uipment 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. [illegible]WITCHES 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 controll including master switches, timers, cut-outs, reversing mechanisms, and other electrical e ome 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 floor-mo ted outlets to be used for plug-in equipment with characteristics as noted on the draw Pro de "Hubbell", or approved equal, three-wire or four-wire grounding-type con d ne e cords installed on each item of plug-in equipment, as indicated on drawings d item s ifica ons.

C. Provide receptacles to match the specific plugs pr ded a rt o e plug-in equipment. Any changes in cords and plugs required in the field due to of c nation shall be the Contractor's responsibility.

D. Reduce the length of all cords furnished h th spec ed equipment to a suitable or appropriate length so they do not interfere with other eq ent o perations.

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

F. All 120 volt, 20 amp recep n kitchen area shall be GFCI (Ground Fault Circuit Interrupting) protected to meet r ome f NEC – Article 210.8(B). Where GFCI circuit breakers are protecting standa recep es, p ide faceplates engraved to read "GFCI" per Division 26 Section 260553, "Ident ation for ectrical Systems" and Division 26 Section 262726, "Wiring Devices".

PART 3 - EXECUTIO

3.1. COO DINATION

A. Locations of outlet boxes, conduit stubs and connection points shown on drawings are for bidding urposes only. Determine exact locations for outlet boxes, conduit stubs and connection points from roved 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.

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 liquid-tight flexible metal conduit. 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 near heat producing equipment.

F. Make conduit connections to equipment using flexible conduit, except use liquid-tight flexible metal 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 wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.

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

3.3. EXHAUST HOODS

A. For kitchen exhaust hoods, provide all required power and control wiring. This shall include (but is not limited to) the following:

1. Provide switch in hoods and branch circuit for integral light fixtures.
2. Provide pushbutton switch or manual starter for exhaust fan.

Provide 120 volt, 20 ampere emergency branch circuit for fire suppression system. Wire automatic heat detectors or manual station; so, when activated, valve of dry chemical bottle opens, gas solenoid valve shuts down, all dampers close, exhaust and make-up fans shut down, electrical power contactor opens (integral in equipment), and building fire alarm system is activated. Provide all required wiring, conduit and final connections. Refer to wiring diagrams supplied with equipment.

Provide connections to kitchen hood extinguishing systems per NFPA 96, 7-3.1.3 for alarm.

D. Wire washdown system: Refer to schematic wiring diagrams supplied with hoods. Interconnect fire prevention system with washdown system so washdown system is activated upon alarm.

E. Wire hood fire suppression system in accordance with the hood fire suppression manufacturer's requirements. Typical functions are: upon activation, gas solenoid valve closes, dampers close, kitchen and hood supply fans shut down, hood exhaust fan starts, electrical circuits to equipment under hood de-energize, and fire alarm system signal associated with the kitchen zone initiates an alarm.

END OF SECTION 260512

SECTION 260513 – MEDIUM-VOLTAGE 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 cables and related splices, terminations, and accessories for medium-voltage electrical cables.

1.3. DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.4. GENERAL:

A. Definition: Medium voltage power cables shall mean all cables rated 5 KV and above.

B. Provide all necessary cables as indicated on the drawings or as specified herein.

C. This specification covers medium voltage conductor shielded power cable suitable for use in wet and dry locations in underground duct systems.

1.5. RATING

A. Fifteen 15 KV cable for use on 12,470V grounded system.

1.6. CODES AND STANDARDS:

A. All cables and accessories furnished under this Section shall be in accordance with the latest applicable standards of AEIC, ANSI, NEMA, IEEE, ICEA, OSHA, and the National Electrical Code. In addition, cable and accessories shall be in accordance with the requirements of local utility company. The requirements of the local utility are in addition to, and in no way a waiver of, the applicable codes and standards.

B. Where any requirements specified herein or shown on the Contract Drawings exceed the listed standards, the Bidder shall adhere to the higher standard. In the case of conflict in requirements between two or more standards, the decision of the Engineer shall be final. Code compliance is mandatory. Nothing in the Drawings and Specifications implies acceptance of work that does not comply with Codes.

C. Where applicable, all equipment and materials shall be listed and labeled by a nationally recognized testing laboratory with equipment listing and follow-up services.

1. American National Standards Institute (ANSI)
   ANSI C2 National Electrical Safety Code
2. National Electrical Manufacturers Association (NEMA)
   NEMA WC8 Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
3. National Fire Protection Association (NFPA)
   NFPA 70-1999 National Electrical Code
4. American Society for Testing and Materials (ASTM):

   a. ASTM B-8 Concentric-Lay-Stranded Copper Conductors; Hard, Medium-Hard, or Soft.
   b. ASTM B-231 Concentric-Lay-Stranded Aluminum Alloy 1350 Conductors

D. Association of Edison Illuminating companies (AEIC): AEIC CS5 EP Rubber Insulated Wire Cable.

E. Insulated Cable Engineers Association (ICEA): ICEA S-66-524 Cable Tested 0-3500X Ozone Resistance

F. Underwriters Laboratories (UL): UL-1072 List of Acceptable Sunlight Resistant PVC Compounds for use as insulating and/or jacketing material on listed outdoor cable cords.

G. AEIC CS 5-1987: Specifications for Thermoplastic and Crosslinked Polyethylene Insulated Shielded Power Cables Rated 5 through 69 kV.

H. AEIC CS 6-1987: Specification for Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 through 69 kV.

I. IEEE 48-1990: Standard Test Procedures and Requirements for High-Voltage Air-Conditioning Cable Terminations (ANSI).

J. IEEE 386-1995: Standard for Separable Insulated Connectors System for Power Distribution Systems above 600 V (ANSI).

K. IEEE 404-1993: Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5000-138,000 Volts and Cable Joints for Use with Laminated Dielectric Cable Rated 2500-500,000 Volts (ANSI).

L. IEEE 576-1989: Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in the Petroleum and Chemical Industry (ANSI).

M. IEEE C2-1996: National Electrical Safety Code (ANSI).

ICEA T-31-610-1994: Guide for Conducting a Longitudinal Water Penetration Test for Sealed Conductor.

NETA ATS-1995: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

P. NEMA WC 7-88 (ICEA S-66-524): Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

Q. NEMA WC 8-88 (ICEA S-68-516): Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

R. NEMA WC 26-90 (including Revision 1 - 1993): Wire and Cable Packaging.

S. NFPA 70-96: National Electrical Code.

1.7. GENERAL REQUIREMENTS

A. All materials supplied by the Contractor shall be new, of recent manufacture, and of the highest commercial grade as specified. They shall be resistant to moisture and corrosion to withstand the environment and operational conditions with minimum maintenance and long life.

1.8. QUALIFICATIONS

A. The manufacturer of the materials specified herein shall have at least ten years of demonstrated experience in the manufacture of the specified product.

B. The manufacturer shall be a company specializing in the manufacture of medium voltage cable and/or accessories with minimum five years documented experience in producing cable and/or accessories similar to those specified below.

C. The cable materials and manufacturer shall meet or exceed all applicable requirements of the latest editions of ICEA Standard S-68-516, AEIC and NEMA Standards.

D. The cable shall be manufactured using the triple extrusion process in which all layers, from the conductor to, and including, the insulation shield, are installed at essentially the same time without an intervening storage step and on reels or other storage devices.

E. Factory Tests:

1. Cable shall be factory tested at high voltage AC, high voltage DC, and for corona discharge in accordance with ICEA requirements.
2. Certification of satisfactory completion of factory tests for cables shall be submitted to the Engineer at the time of cable delivery.

1.9. SUBMITTALS

A. Submit product data indicating cable and accessory construction, materials and ratings.

B. Submit Manufacturer's certificate stating factory test voltage.

C. Submit Manufacturer's installation instructions.

D. Submit Manufacturer's Certificate stating that medium voltage cable meets or exceeds all requirements.

E. Manufacturer's instructions for storage, handling, protection, examination and field testing of cables and accessories before initial energization.

F. Samples: 16-inch (400-mm) lengths of each type of cable specified.

G. Product Certificates: Signed by manufacturers of cables and accessories certifying that the products furnished comply with requirements.

H. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

I. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

J. Product Test Reports: Indicate compliance of cables and accessories with requirements based on comprehensive testing of current products.

K. Medium Voltage Cable Terminating and Splicing Workman's Competency: In order to establish workman's competency regarding medium voltage cable terminating and splicing, Contractor shall be required to submit the following within 30 days prior to commencement of termination of work.

1. Documentation to verify that the individual has completed a termination and splice of the types to be installed, under the supervision of the cable accessory manufacturer, or his representative.
2. Documentation that the dummy termination and splice utilized by the one and passed the following tests, to be performed by the splice kit supplier. These results shall be attached for review.

Test	Minimum Value
Discharge Ext. Value with 3 pc cycles	13 kV
AC Withstand 1 minute	35 kV
DC Withstand 15 minutes	65 kV

3. A statement of the number of years in which the individual has been splicing/terminating medium voltage cables.
4. A list of at least three jobs where specific splices/terminations were installed within the last 12 consecutive months. This list shall include splice/termination manufacturer, catalog number, cable type and the quantity installed.

L. Maintenance Data: For cables and accessories to include in the maintenance manuals specified in Division 01.

1. Include periodic tests of cables in service.
2. Include operation of fault indicators, separable insulated connectors, and accessories.

1.10. QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

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

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

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

E. Comply with IEEE C2 and NFPA 70.

1.11. PROJECT RECORD DOCUMENTS

A. Submit record documents under provisions of Division 01.

B. Accurately record exact sizes, lengths, types, quantities, and locations of cables. Indicate where all splices and terminations are located for each cable.

1.12. DELIVERY, STORAGE AND HANDLING

A. Deliver products to site under provisions of Division 01 and comply with NEMA WC 26.

B. Store and protect products under provisions of Division 01. Store cables and reels on elevated platforms in a dry location.

C. Accept cable and accessories on site in manufacturer's packages and inspect for damages.

D. Protect cable and accessories from weather by covering with opaque plastic or canvas. Provide ventilation to prevent condensation.

E. Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees F, the cable shall be moved to a heated (50 degrees F minimum) location. If necessary, cable will be stored off site.

1.13. SITE REQUIREMENTS

Provide responsibility for all safety requirements on the work site.

F. Comply with OSHA Confined Space Regulations, 8CCR 5156-5158.

C. Barricade open utility holes and pullboxes at all times. Provide for safe flow of traffic and pedestrians.

D. Provide for continuous, mechanically supplied, fresh air to manholes and vaults where workers are inside.

E. All switching of existing circuits shall be performed. Verify that circuits are de-energized and locked out prior to starting work.

F. Scheduled outages that may be required to complete the work will be coordinated with the Owner.

G. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect/Engineer at least two (2) days in advance of proposed utility interruption.
2. Do not proceed with utility interruptions without Engineer/Architect's written permission.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

A. Manufacturer must be able to meet these Specifications as well as the latest edition of Association of Edison Illuminating Company (AEIC) Specification CS6 and applicable industry standards and specifications.

B. The proposed 15 KV cable must be approved acceptable by local utility company.

C. 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. Cables:

a. Okonite Company (The).
b. Prysmian (formally Pirelli) Cable Corporation; Power Cable Division.
c. American Insulated Wire Corporation; Leviton Manufacturing Company.
d. BICC Brand Rex Company.
e. Cable Company, Inc.
f. Kerite Company (The); Hubbell, Inc.
g. Rome Cable Corporation.
h. Southwire Company.

2. Cable Splicing and Terminating Products and Accessories:

3M Company; Electrical Products Division.
b. Elastimold.
c. Engineered Products Company.
d. G & W Electric Company.
e. Mac Products, Incorporated.
f. MP Husky Corporation.
g. Raychem Corporation; Energy Division.
h. RTE Components; Cooper Power Systems, Inc.
i. Scott Fetzer Company; Adalet-PLM Subsidiary.
j. Thomas & Betts Corporation.

2.2. MEDIUM VOLTAGE CABLE - SHIELDED

A. Usage: this cable shall be used for all above and underground applications (except for jumper cable applications. See "Jumper Cable" below) and shall be contained in conduit or other raceways. It may be used in cable trays in electrical vaults only.

B. Cable: Single conductor, insulated cable rated 15 KV, 133% insulation level, ungrounded, NEC-UL Type MV-90. Sizes as indicated on the Drawings.

C. Conductor: Soft copper, annealed, uncoated, Class B compressed or concentric stranded, having nominal direct-current resistance equal to or less than that required in Section 2.5.2 and Table 2-12 of ICEA S-68-516.

D. Conductor Shield: Copper tape, helically applied over extruded semiconductor with resistivity requirements of Section 2.4 of ICEA S-68-516. Material shall be clean stripping from the conductor and firmly bonded to the overlying insulation.

E. Insulation: Extruded EPR (ethylene propylene rubber), rated at 5 KV, 133 percent insulation level, minimum nominal thickness of .115 inches, minimum insulation K factor of 50,000 megohms per 1000 foot length. Manufacturer's Certification of this value shall be a part of submittal for cable approval.

F. Insulation: Extruded EPR (ethylene propylene rubber), rated at 15 KV, 133 percent insulation level, minimum nominal thickness of .220 inches, minimum insulation K factor of 50,000 megohms per 1000 foot length. Manufacturer's Certification of this value shall be a part of submittal for cable approval.

G. Insulation Shield: the insulation shield shall consist of an extruded semiconducting layer directly over the insulation and a coated copper tape over the semiconducting covering. The tape shall be at least 2.5 mils (0.0635 mm) thick and be spirally wrapped with a 12.5 percent overlap. The insulation shield shall meet all requirements of ICEA Section 4.1.

H. Jacket: Black chlorosulfonated polyethylene (CSPE), Polyvinyl Chloride (PVC) or Chlorinated Polyethylene (CPE), all rated AUL @ with a minimum jacket thickness - 80 mils (2.03 mm), meeting all requirements of ICEA.

I. Cable Rating: Continuous duty at 90 degrees C, wet or dry locations, suitable for underground duct installations, NEC/UL Type MV-90, Type USE.

2.3. MEDIUM VOLTAGE CABLE, UNSHIELDED (JUMPER CABLE)

A. Usage: This cable may only be used between equipment in the same vicinity such as between the primary switch and the transformer where adequate through-air clearance can be achieved between the conductors. In general, it is not designed for and shall not be used in metallic raceways.

Cable: Single conductor, flexible, non-shielded, insulated cable-rated 35 KV, ungrounded. Sizes as indicated on the Drawings.

Conductor: Soft annealed copper, uncoated, concentric stranded, having nominal direct-current resistance equal to or less than that in Section 2.5.2 and Table 2-12 of ICEA S-68-516.

Conductor Shield: Extruded semiconductor with resistivity requirements of Section 2.4 of ICEA S-68-516. Material shall be clean stripping from the conductor and firmly bonded to the overlying insulation.

E. Insulation: Extruded EPR (ethylene propylene rubber), rated at 35 KV, minimum thickness of .175 inches, minimum insulation K factor of 50,000 megohms per 1000 foot length. Manufacturer's certification of this value shall be a part of submittal for cable approval.

F. Cable Rating: Continuous duty at 90 degrees C dry locations.

2.4. GENERAL CABLE REQUIREMENTS:

A. Cable shall be single conductor shielded, NEC UL Type MV-90, Class B stranded bare copper, covered with an extruded layer of semi-conducting ethylene-propylene based elastomer (EPR).

B. The insulation shall be an ethylene-propylene elastomer which shall meet or exceed the electrical and physical characteristics of ICEA-S-68-516 and AEIC CS6 (latest edition). The insulation thickness shall be 115 mils for 5 KV, 220 mils for 15kV, and 345 mils for 35kV class service.

C. The insulating compound shall have a maximum ethylene content of 72% by weight and shall contain any polyethylene.

D. The insulation screen shall be an extruded layer of semi-conducting ethylene-propylene based material with a volume resistivity not in excess of 10 ohm-meters (@ 90 degrees C) and shall be applied in accordance with AEIC CS6.

E. Both inner and outer semi-conducting compounds shall have migration after air oven aging at 121 degrees C for 160 hours of 100 percent and a brittleness temperature not warmer than -50 degrees C. The semi-conducting layers and insulation shall be applied using the triple tandem extrusion process.

F. A 5 mil base copper tape shield shall be applied over the outer semi-conducting layer with a nominal 12.5 percent overlap.

G. The overall jacket shall be polyvinylchloride applied in accordance with ICEA S-68-516 Part

H. A permanent marking on the jacket shall indicate cable type, size, conductor type, and rated voltage.

2.5. TERMINATIONS

A. The selected termination system shall be approved by the cable manufacturer. Possible types of acceptable terminators include:

1. Separable Molded Elbow Connectors.

2.6. SPLICE KITS

A. Connectors: IEEE 404, compression type, as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended in writing by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors and splices specified. Include all components required for complete splice, with detailed instructions.

1. Combination tape and cold-shrink ruber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
3. Premolded, cold-shrink rubber, in-line splicing kit.
4. Premolded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

C. Modular Molded Shrink Type Splice; IEEE 404-1986; Class 1; 15 KV. Kit form, suitable for use

with cable specified, including slip-on type flexible polymer or silicon rubber insulator. Splice shall be hot or cold shrink type with internal stress relief tube to distribute electric field (10 percent to 90 percent equipotential lines) over entire length of insulating material.

D. Molded body shall contain a built-in internal semiconducting layer which covers and contacts the splice barrel and the cable insulation layer to prevent electrical stress buildup inside the body. The semiconducting layer shall be bonded to and covered with a cured EPDM rubber or polymeric insulating layer which, in turn, shall be bonded to and covered with a semiconducting layer and metallic shield and jacket.

E. Splicing sleeves shall be long barrel type and rated for the voltage applied.

F. The completed splice shall be approved for underground direct burial and submersible service.

2.7. SOLID TERMINATIONS

A. Multiconductor Cable Sheath Seals: Type recommended by Seal Manufacturer for type of cable and installation conditions, including orientation.

1. Compound-filled, cast-metal body, metal-clad cable terminator for metal-clad cable with external plastic jacket.
2. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.
3. Heat-shrink sheath seal kit with phase and ground-conductor rejacketing tubes, cable-end sealing boot, and sealing plugs for unused ground-wire openings in boot.
4. Cast-epoxy-resin sheath seal kit with wrap-around mold and packaged, 2-part, epoxy-resin casting material.

B. Conductor Terminations: Comply with IEEE 48, as indicated. Insulation class is equivalent to that of cable. Terminations for shielded cables include a shield ground strap.

1. Class 1 Termination for Shielded Cable: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
2. Class 1 Termination for Shielded Cable: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
3. Class 1 Termination for Shielded Cable: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
4. Class 1 Termination for Indoor Shielded Cable; Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.
5. Class 2 Termination for Shielded Cable; Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connectors. Include silicone-rubber tape, cold-shrink rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
6. Class 3 Termination for Shielded Cable: Kit with stress cone and compression-type connector.

C. Termination for Nonshielded Cable; Kit with compression-type connector. Include silicone-rubber tape, cold-shrink rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

2.8. SEPARABLE INSULATED CONNECTORS

A. Separable Insulated Connectors: Modular System complying with IEEE 386. Disconnecting, single-pole, cable terminators and matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cable and modular, dead-front, terminal junctions for interconnecting cables.

C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating, designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight connector for connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.

1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
2. Portable Feedthrough Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand or stationary terminal junction.
3. Grounding Kit: Jumper, elbows, portable feedthrough accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand or stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

F. Test-Point Fault Indicators: Arranged for installation in test points of load-break separable connectors. Self-setting indicators capable of being installed with a shotgun hot stick and tested with test tool. Current-trip ratings as indicated.

G. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.9. ARC-PROOFING MATERIALS

Tape for First Course on Metal Objects: Ten-mil (250 micrometer) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

Arc-Proofing Tape: Fireproofing tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch (13 mm) wide.

2.10. FAULT INDICATORS

A. Indicators: Automatically-reset fault indicator with inrush restraint feature, arranged to clamp to

cable sheath and provide a display after the cable has faulted. Instrument immune to heat, moisture, and corrosive conditions and recommended by manufacturer for installation conditions. Indicators have current-trip ratings and quantities as indicated.

B. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage/carrying case.

2.11. SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682 and ICEA S-94-649 before shipping.

B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610 using a test pressure of 5 psig (35 kPa).

PART 3 - EXECUTION

3.1. EXAMINATION

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

3.2. CABLE PULLING

A. Prior to pulling cable, a mandrel/swab 1/4 inch smaller than the duct diameter shall be pulled through duct run to insure adequate cleaning of duct run. Thoroughly swab conduits to remove foreign material before pulling cables.

B. Cables shall not be pulled in an outside (exterior) or underground systems from an outside (exterior) or underground location when the outside (exterior) air temperature is below 40 degrees Fahrenheit.

C. Furnish all required installation tools to facilitate cable pulling without damage to the cable jacket. Such equipment is to include, but not be limited to, sheaves, winches, cable reels and/or cable reel jacks, duct entrance funnels, pulling tension gauge, and similar devices. All equipment shall be of substantial construction to allow steady progress cone pulling has begun. Makeshift devices which may move or wear in a manner to pose a hazard to the cable shall not be used.

D. Cable ends shall be sealed and firmly held in the pulling device during the pulling operation.

Cable pulling shall be done in accordance with cable manufacturer's recommendations, except as modified herein, and ANSI/IEEE C2 standards. Manufacturer's recommendations shall be a part of the cable submittal. Recommended pulling tensions shall not be exceeded. Pulling bending radius shall not be less than that determined by the manufacturer of the NEC. Actual pulling tensions shall be continuously monitored and permanently recorded in a log and submitted to the Engineer at the end of the project. Restrictions of pulling bending radius dimensions shall be strictly observed. Training bending radius shall not be less than 12 times cable diameter. Any cable bent or kinked to radius less than recommended dimension shall not be installed.

F. During pulling operation, an adequate number of persons shall be present to allow cable observation at all points of duct entry and exit as well as to feed cable and operate pulling machinery.

G. Cable Pulling: Test existing duct lines with a mandrel and thoroughly swab out to remove foreign material before the pulling of cables. Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through the manhole opening and into the duct runs. Cable slack shall be accumulated at each manhole or junction box where space permits by training the cable around the interior to form one complete loop. Minimum allowable bending radii shall be maintained in forming such loops.

H. Cable pulling tensions shall not exceed the maximum pulling tension recommended by the cable manufacturer. Pulling lubricant shall be used to ease pulling tensions. Lubricant shall be of a type which is non-injurious to the cable material used. Lubricant shall not harden or become adhesive with age.

I. Lubricants for assisting in the pulling of jacketed cables shall be those specifically recommended by the cable manufacturer. Cable lubricants shall be petroleum grease for lead-covered cables (soapstone, graphite, or talc for rubber jacketed cables). The lubricant shall not be deleterious to the cable sheath, jacket, or outer coverings.

J. Avoid abrasion and other damage to cables during installation.

K. Where cables are left in manhole or switchgear overnight or more than 48 hours prior to termination, the cable ends shall be sealed with paraffin or shrink type cap and supported in a manner which will prevent entrance of moisture into the cable. Cable shall be terminated and energized as soon as possible.

3.3. INSTALLATION

A. The firm shall be a company specializing in installation of medium voltage cable and accessories with a minimum of five years documented experience in installation of the type of cable and accessories described below.

B. The electricians employed for this work shall be experienced in medium voltage cable installation. Workmen involved in splicing and termination of cables shall have been specifically trained in the procedures required for the splices and terminations used in this project. At the discretion of the Engineer, documentation of experience and/or training in medium voltage cable splicing and termination shall be furnished. At the Engineer's discretion, the electricians making up terminations or splices shall make up a sample splice and/or termination to be used to determine the capability of the electrician(s) involved.

C. Install cables as indicated, according to manufacturer's written instructions and IEEE 576.

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

E. Install direct-buried cables on leveled and tamped 3-inch (75-mm) bed of clean sand at bottom of trench. Separate cables crossing other cables or piping from those items by a minimum of 4 inches (100 mm) of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

F. Install "buried cable" warning tape 12 inches (305 mm) above cables.

G. Install separable insulated-connector components where indicated according to manufacturer's written instructions. Provide the following quantities of components:

1. Protective Cap: Install at each Terminal Junction, one on each terminal to which no feeder

is indicated to be connected.

2. Portable Feed-through Accessory: 3.
3. Standoff Insulator: 3.

3.4. CABLE ROUTING IN UTILITY HOLES AND EQUIPMENT

A. Certain utility holes, as indicated on the drawings, shall have the cable looped around the wa... In such cases, the cable shall circle the manhole at least 360 degrees. Where utility ho... not to looped, cable shall be routed on the walls with the longest distance between points of ...try and ...

B. All new and existing cable in utility holes shall be secured to racks on the utility h... walls. Cables shall be secured to racks with split porcelain insulators and clamps. Ins... openi... shall be of adequate size to contain all three phases and the ground of a given cir...t. Faste...g ca...es directly to support brackets with wire or plastic ties will not be accepted. Su...rt cables ...4' intervals with galvanized steel racks and channels and porcelain insulators or non-...allic c...le racks. Cable weight shall not rest on terminations.

C. Cables within switchgear shall be routed in a manner wh... will allo... adequate room for bending and terminating cables. Cables must be secured in ...anne... which ...ll not result in cable weight being placed on the termination electrical joint. Cable ...port ... be made in a manner that does not force cable against grounded metal or whic... ...press... cable diameter. Cable training bending radius shall be at least 12 times cable diam...r.

D. Jumper cable shall be routed in a manner th... ...event... from contacting any metallic surface.

E. Installation of cables in utility h... handholes an... vaults: Do not install cables utilizing the shortest route, but route along those w... ...is p...viding the longest route and the maximum spare cable lengths. Form all cables to closely ...allel w... ...s not to interfere with duct entrances, and support on brackets and cable insulators at a ...n... ...m of ...5 inches. In existing utility holes; handholes and vaults where new ducts are ...e term...ted or where new cables are to be installed, the existing installation of cables, cable s... ...ports ... gro...ing as required for a neat and workmanlike installation with all cables properly ...ranged a... supported. Support cable splices in underground structures by racks on each side o... ...e splice. ...ocate splices to prevent cyclic bending in the spliced sheath. Install cables a... ...middle ... ...bott...m of cable racks, leaving top space opening for future cables, except as other...se indi...ted fo... existing installations. Provide one spare three-insulator rack arm for each cabl... ...ck i... each underground structure. (Provide cable racks in each underground structure through... ...ch cable is run.)

F. Ground metallic non-current carrying components such as cable racks, switches, and transformers. Use a #6 solid copper conductor, minimum.

G. ...utility holes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

...ERMINATING AND SPLICING

A. Cable Terminating: Protect terminations of insulated power and lighting cables from accidental contact, deterioration of coverings and moisture by the use of termination devices and materials. Install all terminations of insulated power and lighting cables (cable splices) (pot heads) (high voltage terminations) in accordance with the manufacturer's requirements. Make terminations using materials and methods as indicated or specified herein or as designated by the written instructions of the cable manufacturer and termination kit manufacturer. Keep cable ends sealed prior to splicing or termination to prevent the entrance of moisture.

B. Splices in High Voltage Cables: Splices shall be suitable for continuous immersion in water and shall be made only in accessible locations in manholes or handholes. Clearly mark splices buried directly in earth by an identification slab.

C. Certification: High voltage cable splicer/terminator certification of competency and experience sh be submitted thirty (30) days before splices or terminations are made in high voltage cab Splicer/termination experience during the immediate past three years shall include perfor nce splicing and terminating cables of the type and classification being provided under this cont

D. Cast-Type Splice Methods: Cast-type splice insulation shall be provided by mea f a casting process employing a thermosetting epoxy resin insulating material wh shall applied by a gravity-poured method or by a pressure-injected method. The component ma ls o resin insulation shall be in a packaged form ready for convenient mixing wi emo g from the package. Do not allow the cables to be moved until after the splicing aterial com etely set.

E. Kit Methods: High voltage splices shall be made using kit which ll be product of one Manufacturer and shall have the approval in writing of the m er able which is to be spliced. Provide the Contracting Officer Quality Co Repre tative with a copy of the Manufacturer's instructions before splicing is started. Sp shall be de only in utility holes and handholes.

F. Splices in Shielded Cables: Splices in shield les s include covering the spliced area with metallic tape, or like material, to the origina able ield and y connecting it to the cable shield on each side of the splice. Provide a No. WG are pper ground connection brought out in a watertight manner and grounded to a 3/4-inc 10-fo ground rod as part of the splice installation. Wire shall be trained to the sides of the enclos manner to avoid interference with the working area.

G. Splices are to be held to a imum plice locations shall be determined by cable lengths available, pulling conditions and ter ti points. Splice locations are to be listed by the Contractor prior to cable purchase and listing such locations submitted to the Engineer for approval before final cable lengths are term

H. Only experien electrici s shall be employed in this phase of the work. Refer to Quality Assuran above

I. Foll cabl manufacturer's and splice or termination manufacturer's installation instructions and ANSI/ C2 standards.

J. Clean, white lint-free gloves shall be used to handle the end of the cable during tape wrapping procedures.

K. mination or splicing of the copper conductors (both power and ground conductors) shall be made only with tool-applied compression (swaged) fittings.

L. Ground system connections:

1. Cable to Bus: Compression cable fitting bolted to bus with lock washers under nut.
2. Cable to Ground Rod: Approved bolted fitting with backing plate between cable and rod.

M. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware according to manufacturer's written instructions.

N. Splice or termination failure upon high potential acceptance test will require complete

reconstruction of the joint to Manufacturer's Specifications. Make sure that there is enough free cable at each termination or splice for two more terminations or splices to be performed.

O. Install Scotch #70 tape for anti-tracking on all exposed terminations.

P. All splices and terminations are to be tagged using embossed plastic tags with plastic attachment devices indicating date splice or termination was made, name of electrician involved, name of Contractor installing cable, feeder number and circuit to and from data.

Q. All cable splices in manholes shall be supported on both sides of the splice within 2'0" of the splice. Splices shall not rely on cable for support.

R. Lugs shall be bolted to termination pads in equipment using corrosion resistant bolts, nuts, and washers. Use Belleville washers for bolting aluminum to aluminum and lock washers for bolting copper to copper or as recommended by equipment manufacturer. Washers shall be in the lug side. Torque to Manufacturer's recommendations.

S. Install splices at pull points and elsewhere as indicated. Use standard kits. Comply with kit manufacturer's written instructions.

T. Install terminations at ends of conductors and seal medium voltage cable ends with standard kits. Comply with kit manufacturer's written instructions and with classes of terminations indicated.

3.6. FIRE-PROOFING AND ARC PROOFING

A. Fireproofing (Arc Proofing) of Cables in Utility Holes, Handholes, and Vaults: All wire and cables which will carry current at 2,000 volts or more in manholes, handholes, and vaults shall be fire-proofed.

B. Exposed cables in utility holes shall be fireproofed. Entire installation shall conform to Manufacturer's recommendations.

C. Arc proofing material shall be Scotch #77 electrical arc and fireproofing tape, or approved equal.

D. Install the fireproofing on the cables as follows:

1. Install tightly applied fireproofing tape, approximately 1/16-inch thick by 1-1/2 inches wide minimum, around each feeder spirally on one-half-lapped wrapping.
2. Install the tape with the coated side towards the cable and extend it not less than one inch into each duct.
3. Install random wrappings of Scotch #69 glass cloth tape around the installed fire-proofing tape per Manufacturer's instructions to prevent it from unraveling.

E. Fireproofing Tape: Strips of fireproofing tape approximately 1/16-inch thick by 3 inches wide shall be wrapped tightly around each cable spirally in half-lapped wrapping, or in two butt-joined wrappings with the second wrapping covering the joints in the first. The tape shall be applied with the coated side toward the cable and shall extend one-inch into the ducts. To prevent unraveling, the fireproofing tape shall be random wrapped the entire length of the fireproofing with pressure sensitive glass cloth tape. The fireproofing tape shall consist of a flexible, conformable fabric having one side coated with flame retardant flexible, polymeric fabric having one side coated with flame retardant, flexible, polymeric coating and/or a chlorinated elastomer not less than 0.050 inch thick and shall weigh not less than 2.5 pounds per square yard. The tape shall be noncorrosive to cable sheath, shall be self-extinguishing, and shall not support combustion. The tape shall not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.

F. Arc Proofing: Arc-proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials, unless otherwise indicated. Apply as follows and as recommended by manufacturer of arc-proofing tape:

1. Clean cable sheath.
2. Wrap metallic cable components with 10-mil (250-micron) pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with 1-inch-(25-mm-) wide bands of half-lapped, adhesive, glass cloth tape 2 inches (50 mm) o.c.

3.7. PHASING

A. Verify by hot phase test that cables on loop and tie circuits are matched phase-to-phase at every splice or termination that occurs at an open point. Use an approved phase-line phasing meter and follow safety and switching procedures. This test may only be performed by personnel experienced in and qualified for testing of energized circuits. Do not rely on color markings for assurance of proper phasing.

B. Verify correct phase rotation when cables on radial circuits are replaced. Use approved secondary voltage rotation tests or verify that the rotation of existing motors is correct.

3.8. FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing agency to perform field quality-control testing.

B. Testing: On installation of medium-voltage cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.2.
2. Certify compliance with test parameters.

C. Correct malfunctioning cables and accessories at project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

D. Test and inspect cables according to NEMA WC 7 (ICEA S-66-524) and NEMA WC8 (ICEA S-68-516) before shipping.

E. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

F. Tests shall be performed on completed cable in accordance with ICEA S-68-516 and AEIC CS6 (latest edition) as specified.

1.	Conductor Resistance	per AEIC Paragraph 1.2
2.	AC Withstand (5 minutes)	5 kV - 22 kV 15 V - 44 kV 35 kV - 69 kV
3.	IR Constant (at 15.6 C), min.	50,000 megohms - 1000 feet
4.	DC Withstand (15 min.)	5 kV - 45 kV

15V - 80 kV
16 35 kV - 125 kV

5. Partial Discharge — Per AEIC, 5 pc max. at 4 times rated voltage

G. Test Reports: Certified test reports shall be furnished for all cables.

H. Field inspection and testing will be performed under provisions of Division 1.

I. Inspect exposed cable sections for physical damage. Verify that cable is connected according to Drawings and that shield grounding, cable support, and terminations are properly installed.

J. Perform DC high potential test of each conductor, with other conductors grounded, in accordance with the manufacturer's recommendations and IEEE Standard 400, Article 5 - "Direct Voltage Testing". Apply test voltage to conductors in at least eight equal increments to maximum test voltage. Record leakage current at each increment, allowing for charging current decay. Hold maximum test voltage for ten minutes.

K. Record results of test in tabular form and in plots of current versus voltage for incremental voltage steps, and current versus time (30 second intervals) at maximum voltage. Curves shall be identified with the cable to which they apply and shall be certified. Time of day, outside temperature and humidity at time of each test shall appear on each data sheet.

L. Perform shield continuity tests.

M. Perform phasing checks.

N. If any primary cable fails, tests ... opinion of the Owner, unacceptable cable defects, all cables in that conduit between the nearest pulling points on each side of the failure shall be removed. If, in the opinion of the Owner, other cables that may have been installed in the same duct are not damaged, they may be reinstalled, but the failed cable shall be replaced with new cable without additional charge.

O. After replacement of faulty cable, and any other damaged cables, all cables of the circuit in that conduit shall be re-tested. If the cable fails again, or if tests, in the opinion of the Architect, show unacceptable cable defects, all cables shall be replaced without charge and this procedure shall be repeated until tests prove satisfactory.

3.9. CABLE IDENTIFICATION AND LABELING

A. Provide the following information on cable identification label:

1. Main feeder circuit breaker number.
2. Phase.
3. To and From Data.

B. Install cable labels on each conductor at each cable termination, each cable splice, in each manhole and in each pullbox. Additionally, at these locations, provide on inch (1") colored vinyl plastic electrical tape wrap identification, (Scotch 35 or approved equal) around each conductor and cable as follows:

1. 15 kV individual conductor system:

a. A - Phase - one (1) red wrap.
b. B - Phase - two (2) red wraps with ½-inch space between wraps.
c. C - Phase - three (3) red wraps with ½-inch space between wraps.

C. See paragraph above under "Terminating and Splicing" for splice label requirements. This is in addition to identification labels.

D. During entire cable installation, phasing of conductors shall be maintained and identified. Where final connections to equipment are made, phasing shall be verified and proper phase rotation determined prior to connection.

E. Identify cables as to manufacturer, year, voltage, size, temperature, rating and ampacity. If such identification is not visible on the surface, the information shall be identified on an engraved lamicoid tag permanently secured to the cable in each accessible location.

F. Identify cables with circuit number and last and next accessible location at each substructure with an engraved lamicoid nameplate.

G. Cables shall be identified in every manhole and pullbox by voltage, circuit name, and location of next accessible point. Identification tags shall be stamped metal or engraved lamicoid nameplate, red with white letters, approximately three-inch by five-inch (3-inch x 5-inch), fastened with 12 AWG copper wire.

3.10. PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to Manufacturer and Installer, to prevent entrance of moisture into the cables and to ensure medium-voltage cables are without damage or deterioration at time of Substantial Completion.

END OF SECTION 260513

SECTION 260519 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SUMMARY

A. This Section includes 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 as 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 V 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. Store and handle 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 "Low-Voltage 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. Colonial Wire Company.
d. Encore Wire.
e. General Cable.
f. Senator Wire & Cable Company.
g. Southwire Company.

2. Connectors and Accessories for Wires and Cables:

a. 3M Company; Electrical Products Division.
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 [illegible] 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 [illegible] ral 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:

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

3. 120/240-Volt, 1-Phase, 3-Wire System:

a. Phase A: Black
b. Phase B: Red
c. Neutral: White
d. 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; silver bet... conductors; beveled cable entrances.

F. Compression (crimp) Connectors: Long barrel; seamless, tin-plated electr... 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 C... 1986 ...uried 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 ... 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 ... 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 ... 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
   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. 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 -40 degrees Celsius to 90 degrees Celsius.
6. Basis of Design: IPLM/IPLMD Series as manufactured by Polaris, or approved equal.

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

1. Description: Multi-conductor connectors for low voltage (1000V 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 for #8 AWG 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: GI 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 copper grounding conductor. Conductors shall be cabled together with a binder tape bearing a print legend that is wrapped around the assembly. An interlocked armor shall be applied over the assembly. Conductors shall be protected by an anti-short bushing at each termination.

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, ring-style 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. VFD CABLE

A. Description: Type TC-ER cable designed for use with variable frequency controllers (VFCs), with extra-flexible stranded conductors, oversized crosslinked polyethylene (XLPE) insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer polyvinyl chloride (PVC) or thermoplastic elastomer (TPE) jacket.

B. Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.

2.7. DROP CORDS

A. Description: Continuous length of cable with locking blade type connector body at lower end as indicated on Drawings. Secure cable at both ends with wire type stainless steel cable grips to prevent transmission of tension directly to conductors or terminal screws.

B. Junction Box: Furnished and installed flush with ceiling anchored to building structure for fastening of upper cord grip.

C. Cable: Type SO 600 volt flexible cord with three 12 AWG wires.

D. Connector Body: Single 120 volt, grounding receptacle of twistlock type that grips on cable insulation and is manufactured for use with wire cable grips. Furnish and install drop cords in length required for a receptacle height of 6 feet 8 inches above the finished floor.

2.8. 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, and in accordance with the manufacturer's recommendations.

C. Supports: Provide cable supports of the wedge type which firmly clamp 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 INSTALLATION 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. All emergency wiring shall have the same color coding but shall clearly be identified as emergency in all outlets, fixtures, etc.

F. Switch leg wire shall be labeled with "S" tag.

G. 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				

H. 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 and suitable for the conductor sizes involved.

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

J. Joints of 8 AWG and larger shall be of the type implemented 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.

K. 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.

L. Provide extra flexible VFD cable for VFD output circuits.

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

D. 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.

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

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

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

H. 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 260529, "Hangers and Supports for Electrical Systems".

F. Seal around cables penetrating fire rated elements according to Division 26 Section 260528, "Firestopping for Electrical Systems".

G. Identify wires and cables according to Division 26 Section 260553, "Identification for Electrical Systems".

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 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 "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, in Kitchen hoods, 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. Cable bends will have a radius not less than the value recommended by the cable manufacturer.

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

AA. 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 with 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 pressure 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 and 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 260553, “Identification for Electrical Systems”.

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 ground conductors are only terminated at grounding lugs/bus.

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 testing 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 megohmmeter tests of all 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 Celsius.
   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.

6. Infrared Scanning: Perform an infrared scan of each splice and termination in conductors 4/0 AWG and larger, 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.

END OF SECTION 260519

SECTION 260520 - ELECTRIC HEATING 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 heating cables for the following applications:

1. Heat tracing for freeze protection.

1.3. DEFINITIONS

A. AWG: American Wire Gauge.

B. C: Celsius.

C. F: Fahrenheit.

1.4. SUBMITTALS

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

B. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer installed and field installed wiring.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

D. Maintenance Data: For electric heating cables to include in maintenance manuals specified in Division 01.

E. Warranties: Special warranties specified in this Section.

1.5. QUALITY ASSURANCE

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

1.6. COORDINATION

A. Coordinate layout and installation of electric heating cables and system components with other

construction.

1. Coordinate with Food Service Equipment installer for piping installed under Division 11.
2. Coordinate with piping installer, for condensate and sanitary piping provided under Division 22 and 23.

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, executed by manufacturer agreeing to repair or replace components of electric heating cables that fail in materials or workmanship within specified warranty period.

C. Warranty Period: Two years from date of Substantial Completion.

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. Accutron Heat Tracing Systems.
2. Ari Industr[illegible]
3. BICC P[illegible]otenax [illegible]A In[illegible]
4. Calori[illegible] Inc.
5. Chrom[illegible]x; Wieg[illegible] Industrial Division; Emerson Electric Company.
6. [illegible]opper[illegible] Inc.
7. Delta[illegible]herm Corp.
8. Ea[illegible] Heat, Inc.
9. [illegible]DEECO.
10. M[illegible]on Corp.; Infloor Heating Systems Div.
11. Nelson Heat Tracing Systems.
12. Omega Engineering Inc.
13. Raychem Corporation.
14. Thermon Manufacturing Co.

2.2. ELECTRICAL HEAT TRACING FOR PIPELINES

A. The self-regulating heater shall consist of two (2) 16 AWG nickel coated-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heater to be crossed over itself without overheating, to be used directly on plastic pipe, and to be cut to length in the field. The heater shall be covered by a radiation cross-linked modified polyolefin dielectric jacket.

B. In order to provide energy conservation and to prevent overheating, the heater shall have a self-regulating factor of at least 90 percent. The self-regulation factor is defined as the percentage

reduction, without thermostatic control, of the heater output going from 40 degrees F pipe temperature operation to 150 degrees F pipe temperature operation.

C. The heater shall operate on line voltages of 120 volts without the use of transformers.

D. The heater shall be sized according to this table. The required heater output rating is in watts per foot at 50 degrees F.

Pipe Size	Watts per foot
3 inch or less	5 watt
4 inch	5 watt
6 inch	8 watt

E. Power connection, end seal, splice and tee kit components shall be approved in the field.

F. The system shall be controlled by a thermostat set to 40 degrees either directly or through an appropriate contactor.

2.3. DOMESTIC WATER PIPING FREEZE PROTECTION CONTROLS

A. Heat trace cables providing freeze protection for water piping shall be controlled by an electronic outdoor thermostat.

B. Outdoor thermostat shall utilize a probe to sense outdoor ambient air temperature, and shall have adjustable temperature range from 30 to 110 degrees Fahrenheit (-1 to 43 degrees Celsius).

C. Thermostat switch shall be rated at 120VAC, 30 amperes.

D. Provide Raychem Digitrace DC-TS-AMB ambient sensing electronic thermostat, or approved equal by listed manufacturer.

2.4. ACCESSORIES

A. Cable Installation Accessories: Tapes, cable ties, warning labels, end seals and splices, and installation clips.

PART 3 - EXECUTION

3.1. EXAMINATION

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

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
2. Ensure pipe testing is complete.
3. Ensure surfaces and substrates are level and plumb.

B. Test cables for electrical continuity before installing.

C. Test cables for insulation resistance before installing.

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

3.2. INSTALLATION

A. Cut cable(s) to lengths required.

B. Install heater to cold lead connections in accessible locations. Do not embed in concrete or plaster.

C. Avoid crossing expansion, construction, or control joints with heating cables. Provide sufficient slack conductor in expansion loop.

D. Provide labels for piping insulation/jacketing to identify the line "electrically heat-traced".

3.3. CONNECTIONS

A. Electrical installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of wiring, conduit, and specific

B. Connect heating cables and other components to wiring systems.

C. Ground equipment:

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

3.4. FIELD QUALITY CONTROL

A. Testing: Perform tests after installation but before application of coverings, such as insulation, plaster, or concrete.

1. Test cables for electrical continuity before energizing.
2. Test cables for insulation resistance before energizing. Remove cables if measured resistance is less than 10 megohms to ground.
Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation.

C. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.5. ADJUSTING

A. Set field adjustable thermostat ranges as indicated.

3.6. PROTECTION

A. Protect installed heating cables, including leads, from damage prior to Substantial Completion.

END OF SECTION 260520

SECTION 260524 – MEDIUM-VOLTAGE GROUNDING

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 medium voltage grounding including, but not limited to the following:

1. Conductors
2. Connectors
3. Electrodes

B. Related requirements of the following Sections shall apply to this Section:

1. Division 26 Section 260519, "Low-Voltage Electrical Power Conductors and Cables"
2. Division 26 Section 260526, "Grounding and Bonding for Electrical Systems"
3. Division 26 Section 260543, "Underground Ducts and Raceways for Electrical Systems"

1.3. REFERENCES

A. ANSI/IEEE 32 - Requirements, Terms and Test Procedures for Neutral Grounding Devices.

B. ANSI/IEEE C2 National Electrical Safety Code.

C. ANSI/IEEE 80 - Guide for Safety in Substation Grounding.

D. ANSI/IEEE 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

1.4. SYSTEM DESCRIPTION

A. The medium voltage system utilized is 12,470/7,200 Volts (WYE) connected.

1.5. PROJECT RECORD DOCUMENTS

A. Submit documents under provisions of Division 01 and Division 26 Section, "Common Work Results for Electrical", Article "Record Drawings".

B. Accurately record exact locations of neutral and equipment grounding points and ground electrodes.

1.6. REGULATORY REQUIREMENTS

A. Conform to ANSI/IEEE C2.

B. The underground distribution system shall be properly grounded, meeting all requirements of the National Electrical Code, other applicable Federal, State and local electric codes, and requirements of these Specifications.

1.7. QUALITY ASSURANCE

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

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3 of this Section.

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

C. Comply with UL 467 "Standard for Grounding and Bonding Equipment" for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1. CONDUCTORS

A. Bare Copper Conductors

1. Stranded Conductors: ASTM B 8.

2.2. CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors: Copper or copper alloy, bolted pressure-type, with at least two bolts.

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

2.3. 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. INSTALLATION

A. Install grounding equipment in accordance with Specifications and Drawings

B. System shall include, but not be limited to, the following:

1. Ground rods for grounding the medium voltage distribution system shall be installed at every manhole, switchgear, and transformer.
2. Each manhole shall contain a ground rod driven below the manhole, but with an accessible top.
3. Provide 1/0 AWG 600 Volt insulated, stranded copper ground wire with THWN insulation in each duct with medium voltage cables and bonded at each manhole and termination point.

3.2. FIELD QUALITY CONTROL

A. Test resistance to earth of grounding connections in accordance with ANSI/IEEE 81. Use two-point method test to determine resistance between main system and neutral. Test cable in accordance with NETA ATS (Acceptance Testing Specifications), Section 7.14, for electrical power distribution equipment.

B. Maximum Acceptable Ground Resistance: 5 ohms.

C. A resistance of not greater than 5 ohms shall be required at all MV equipment pads, manholes, etc. Ground resistance shall be measured in normally dry conditions, not less than 48 hours after a rainfall. When a 5 ohm reading cannot be obtained, additional ground rods may be driven and connected to others in order to obtain a resistance less than 5 ohms.

D. Investigate levels which exceed the above.

END OF SECTION 260524

SECTION 260526– GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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

B. Refer to Division 26 Section 260519, "Low-Voltage Electrical Power 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 the electrical service system neutral at service entrance equipment to grounding electrodes and metallic water service as supplemental.

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

D. 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.

F. TMGB: Telecommunications main 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 grounding rods, 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, certified by Testing Agency.

1.5. QUALITY ASSURANCE

A. Testing Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7, or a full member company of the International Electrical Testing Association (NETA).

1. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3 of this Section.

B. Comply with NFPA 70 - National Electrical Code.

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

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

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

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

G. Comply with ANSI C33.8.

H. 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, test wells, 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 260519 "Low-Voltage Electrical Power 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 Conductor: 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. Underground Conductors: Bare, tinned, stranded, 4/0 AWG size minimum, except as otherwise indicated.

E. 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 oxygen free hard drawn copper. The conductivity of this material shall be no less than 99 percent of 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.

C. Exothermic Connections: Provide exothermic-weld kit selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

2.6. GROUNDING ELECTRODES AND TEST WELLS

A. Ground 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.

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

3. Ground rods shall be UL listed #467.

. Test Wells: Fabricate from 15-inch- (400-mm-) long, square-cut sections of 8-inch- (200-mm-) diameter, Schedule 80, PVC pipe.

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 systems 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. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

3. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and above, including air cleaners and heaters. Bond conductor to each unit and to air duct.

4. Water Heater, and Heat-Tracing Circuits: Install a separate equipment grounding conductor to each electric water heater, heat-tracing assembly, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

B. Telecommunications System Grounding:

1. Refer to technology drawings for information.

2. Provide one (1) 6 AWG bonding conductor from each telecommunications grounding bus bar to the electrical panelboard serving the circuits in the respective IDF room.

3. Provide ancillary bonding connections from each TGB and TMGB to telecommunications equipment as detailed on the Contract Documents.

C. Mechanical System Grounding:

1. The incoming domestic and fire protection water services shall be bonded to the electrical grounding system; provide equipment grounding conductor (EGC) sized per the National Electrical Code.

2. The incoming natural gas service shall be bonded to the electrical grounding system; provide equipment grounding conductor (EGC) sized per the National Electrical Code.

3. 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.

4. 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. Generators:
   a. Generators shall only be considered a separately derived system where the system grounded conductor (neutral) does not have a direct electrical connection to the building system.
   b. Provide a grounding electrode conductor from the generator to the nearest grounding electrode.
   c. Provide an equipment grounding conductor from the generator enclosure to the transfer switch enclosure.
   d. Provide a system bonding jumper from the generator neutral point to the generator grounding point.
   e. Refer to Division 26 Section "Generator Assemblies" for additional requirements.
   f. Refer to Division 26 Section "Automatic Transfer Switches" for four-pole transfer switches used in separately derived systems.

3. Metal Water Pipe:
   a. Interior 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.

4. 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.

5. 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 a minimum of three (3) grounding electrodes, unless otherwise indicated on the Drawings, 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, except at test wells, 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 [redacted] 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 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. Test Wells: One for each driven grounding electrode, except as otherwise indicated. Set top of well flush with finished grade or floor. Fill with 1-inch- (25-mm-) maximum-size crushed stone or gravel.

H. 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.

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.

Ground buses and neutral buses in all switchboards, 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.

K. 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.

L. 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. The ground bus shall be bonded to both the system neutral and the service ground.

M. 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 separate grounding pole.

N. Grounding of exterior fence shall include ¾-inch x 8'-0-inch ground rods, ground clamps, flexible braided straps and other accessories as required for a complete ground system for fencing. Total resistance to ground shall not exceed 10 ohms.

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, except those at test wells. Comply with manufacturer's written instructions. Welds that are burned 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. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and grounding rods.

F. 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.

G. 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.

3.4. UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Grounding System: Ground pad-mounted equipment by connecting them to underground cable and grounding electrodes.

3.5. FIELD QUALITY CONTROL

A. Independent Testing Agency: Engage an independent electrical testing organization to perform tests described below.

B. Tests: Subject the completed grounding system to a megger test at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than 2 full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or any artificial means of reducing natural ground resistance. Perform tests by the 2-point method according to IEEE 81.

C. Maximum grounding to resistance values are as follows:

1. Equipment Rated 500 kVA and Less: 10 ohms.

2. Equipment Rated 500 to 1000 kVA: 5 ohms.

3. Equipment Rated More than 1000 kVA: 3 ohms.

4. Manhole Grounds: 10 ohms.

D. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify Owner promptly and include recommendations to reduce ground resistance and to accomplish recommended work.

E. Report: Prepare test reports, certified by the testing organization, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results. Submit all tests to the Architect for approval.

3.6. ADJUSTING AND CLEANING

Restore surface features, including vegetation, at areas disturbed by work of this Section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 260526

SECTION 260528 – FIRESTOPPING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SUMMARY

A. Section includes:

1. Through-penetration firestopping in fire rated construction.
2. Through-penetration smoke-stopping in smoke partitions.

B. Related items: Raceway seals and manufactured electrical devices. Refer to Division 26 Section 260533, "Raceway and Boxes for Electrical Systems".

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, smoke barrier 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 ra... including resistance to cold smoke at all penetrations, connections w... other surfaces or types of construction, at separations required to permit building movem... and ...nd or vibration absorption.
2. Smoke barrier construction: Maintain barrier and structural floor resis...ce to cold smoke at all penetrations, connections with other surfaces and t... of cons...ction and at all separations required to permit building movement and sound ...ibrati... absorption.

1.6. SUBMITTALS

A. Submit in accordance with Division 01, unless otherwi... indica...

B. Product Data: Manufacturer's specificatio... and t...al data including the following:

1. Detailed specification of constructi... nd fa...cation.
2. Manufacturer's installation instructio...

1.7. QUALITY ASSURANCE

A. Installer's qualifica... Firm experienced in installation or application of systems similar in complexity to th... requi... for t... project, plus the following:

1. A...cep...le to or li...nsed by manufacturer, State or local authority where applicable.
2. ...t least ... ...perience with systems.
3. Succ...fully completed at least 5 comparable scale projects using this system.

B. Local a... tate regulatory requirements: Submit forms or acceptance for proposed assemblies not conformin... 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. ...nufacturer 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 backing 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 fail 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. SMOKE-STOPPING AT SMOKE PARTITIONS

A. Through-penetration smoke-stopping: Any system complying with the requirements for through-penetration firestopping in fire-rated construction, as specified in "The Systems and Application Schedule" in Part 3 of this Section, is acceptable, provided that the system includes the specified smoke seal or will provide a smoke seal. The length of time of the fire resistance may be disregarded.

2.4. ACCESSORIES

A. Fill, void or cavity materials: As classified under category XHHU 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 substrates 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. Install smoke stopping as specified for firestopping.

F. 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, CP 25N/S CAJ1006 CP 25WB+, FS-195+ CAJ1007 FS-195+, 1 inch& 2 inch Wide CAJ1008 2000, 2000+, 2003 CAJ1009 2000, 2000+, 2003 CAJ1012 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+ CBJ1021 CS-195+, MPS-2+ CBJ1031 2001 CBJ1032 2001	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
	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	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	FC2002 FS-195+, PPD FC2007 FS-195+, PPD'S 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 2000, 2000+, 2003 CAJ3009 2000, 2000+, 2003 CAJ3010 2000, 2000+, 2003 CAJ3011 2001 CAJ3012 FD 150 CAJ3015 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 Combos	CAJ8001 CS-195+ FS-195+ CAJ8003 2000, 2000+, 20003 CAJ8004 2000, 2000+, 20003 CAJ8006 2001 CAJ8013 FS-195+, CP 25 CBJ8004 CS-195, FS-195+	WL8002 CS-195+, FS-195+	

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

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

END OF SECTION 260528

SECTION 260529 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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

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

1. Division 26 Section 260500, "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, sealing 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 bearing areas. Provide all engineering and fabrication as required for installation of support systems.

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.

Submit for review, shop/assembly drawings and layout drawings of concrete pads and equipment supports for major items of equipment.

D. Submit structural calculations for approval. Calculations include stress and deflection analysis. Submit design criteria and selection calculation.

E. 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. All Strut Support System components must be supplied by a single manufacturer.

F. 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 cover.

1.6. GUARANTEE

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 provided with zinc coating or with treatment of equivalent corrosion-resistance using appropriate external 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.

C. Kitchens & Foodservice Areas: Supports, support hardware, and fasteners installed in kitchens and other foodservice areas shall be 304 stainless steel.

D. Corrosive Locations: Supports, support hardware, and associated fasteners installed in corrosive locations, including but not limited to greenhouses, etc. shall be type 316 stainless steel, or fiberglass (polyester, PVC, vinyl ester).

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:

   1. Sixteen-gauge channels with 9/16-inch-diameter slotted holes at a minimum of two inches on center in top surface.
   2. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer.
   3. Provide plastic end caps for ends of u-channel at free-standing equipment supports and exterior locations.

E. Concrete Equipment Pads:

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

F. Floor-Mounted Stands: Construct with structural steel members or steel pipe and fasten with flange bolted to the floor.

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

H. 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, 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, installer shall not proceed until satisfactory corrections are completed.

3.2. INSTALLATION

A. Installation shall be accomplished by a fully trained manufacturer-authorized installer.

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

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

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

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

F. 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.

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

H. 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.

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

J. 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

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

L. Locations:

1. Anchor bolts, sleeves, inserts, hangers, and supports required for 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 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.

M. 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 explosive 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 lighting fixtures directly from structural slab, deck, or framing members. Refer to Division 26 Section "Interior Lighting" for additional installation requirements.
7. 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.
8. 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.

9. 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.

10. 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.
11. Equipment shall not be held in place by its own dead weight. Provide base and/or fasteners in each case.
12. 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.
13. Vertical conduits shall be supported by heavy wrought iron clamps or collars anchored to construction at each floor.

N. 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.

O. 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	
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
1-1/4	---	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 260529

SECTION 260533 RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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

B. Related Sections include the following:

1. Division 26 Section 260519, "Low-Voltage Electrical Power Conductors and Cables" for conductors installed in raceways and boxes and conductor terminations.
2. Division 26 Section 260528, "Firestopping for Electrical Systems" for requirements for firestopping at penetrations through walls and floors that are fire barriers.
3. Division 26 Section 260529, "Hangers and Supports for Electrical Systems" for raceways and box supports.
4. Division 26 Section 260543, "Underground Ducts and Raceways for Electrical Systems" for raceways installed in ductbanks and ductbank accessories.
5. Division 26 Section "Wiring Devices" for devices installed in boxes.

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. [illegible]
e. PVC
f. PVC externally coated, rigid steel conduits
g. RGS
h. Wireways

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

a. Device boxes
b. Outlet boxes
c. Pull and junction boxes
d. Floor boxes]
e. Audio/Video wall and/or ceiling boxes
f. 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.

1.4. SUBMITTALS

A. Product Data: For raceways, wireways and fittings, floor boxes, 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.

F. Coordinate floor box locations with Architect to ensure coordination with furniture arrangement.

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 System, Inc.
h. Grinnell Co.; Allied Tube & 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. Carlon 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. 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 Hoffma
g. Hubbell Inc.; Killark Electric Manufact ng Co.
h. Hubbell Inc.; Raco, Inc.
i. Lamson & Sessions; Carlon Elect l Pro ts.
j. Z/Gedney; Unit of General Signal.
k. Parker Electrical Manufactu Co.
l. Robroy Industries, Inc.; E ctric Divisio
m. Scott Fetzer Co.; Adal LM
n. Spring City Electrical Ma cturin Co.
o. Thomas & Betts Corp.
p. Woodhead Ind tries, Inc.; Da el Woodhead Co.

6. Floor Boxes:
a. Carlon
b. Hubbell, Inc. Wiring Devices Division
c. SR, I
d. Legrand/ remold
e. Square D ompany

7. Audio/Vide Wall/Ceiling Boxes:

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: Hinged 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.

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.

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.

2.12. FLOOR BOXES

A. Individual, floor-mounted power, microphone, telephone, data, CATV, etc., outlets [illegible] plans. [illegible] multiple floor devices, combine outlets or jacks in common divided box with sing[illegible] multi[illegible] coverplate.

B. General:

1. Flush-mounted, rectangular boxes: 1, 2, or 3 gang as indica[illegible]on the dr[illegible]wings.
2. Carpet trim ring for devices in carpeted areas. Provide carpet [illegible]rt.
3. For tile, wood, or other hard floors, provide flush tri[illegible]verp[illegible] with no projections above the floor surface. Architect to select from [illegible]ass or alu[illegible]num coverplates.
4. Single or multi-gang coverplates as required.

C. Construction:

1. Non-metallic with depth marking[illegible]
2. 1, 2, or 3 divided compartments[illegible]
3. Ratchet adjusting ring for 10 degre[illegible] post[illegible]our adjustment of cover flange.
4. UL listed for protection against scrub[illegible]
5. Walker Omnibox 880M[illegible]eries, or equa[illegible].

D. Receptacles, jacks and [illegible]nector[illegible] Provide receptacles, data, telephone, CATV and other connectors and wiring as in[illegible]r on the Drawings.

2.13. MULTI-SERVICE FLO[illegible]R BOXES

A. Comple[illegible]n-floo[illegible]lti[illegible]rvice box consisting of floor box housing, flush removable cover, and wirin[illegible]devices[illegible]s specified, all fittings, materials and labor.

B. Make a[illegible]tments in leveling and placement during rough-in to accommodate structural and architectur[illegible]lements, and other equipment. Coordinate exact locations with Owner prior to concrete pour.

C. Construction:

1. Formed steel with corrosion-resistant coating unless otherwise noted on the Drawings.
2. Galvanized steel per ASTM 525 G-60.
3. Concrete-tight for in-floor use.
4. Adjustable legs for leveling and adjustment prior to pour.
5. Knockouts for conduit entry and feed-through use.
6. Four (4), Six (6) or eight (8) wiring compartments, individually sectionalized, as indicated on the contract drawings.

a. Half of wiring compartments shall have duplex 5-20R power receptacles.
b. Remainder of wiring compartments shall have six-port low-voltage activation kits for technology/communications outlets, unless otherwise indicated on the drawings.

7. UL listed, with separation of power and low voltage**.**
8. Hinged, completely flush cover with cable ports. Cover shall be flanged. Finishes shall be selected by Architect from manufacturer's full range of options.
9. Provide terrazzo ring for all floor boxes installed in finished concrete floors or receiving flangeless covers.

D. Provide EFB Multi-Service recessed floor boxes as manufactured by Wiremold/Legrand, or approved equal.

2.14. FIRE-RATED MULTI-SERVICE POKE-THROUGH DEVICES

A. Complete fire-rated multi-service poke-through device providing power, voice/data communications and A/V connectivity in an above grade concrete floor where power and communication devices are required. Poke-through devices enable such devices/outlets for wiring and cabling in an open floor plan using core-drilled slab openings that will not obstruct the floor area.

B. Specific codes and standards apply to electrical wires and telecommunication cables that are deployed within poke-throughs. Codes that are enforced by the local Authority Having Jurisdiction (AHJ) must be observed during construction.

C. Make adjustments in placement during rough-in to accommodate structural and architectural elements, and other equipment. Coordinate exact locations with Owner prior to core-drilling concrete floors.

D. Classification and Use: Poke-through devices shall have been examined and tested by UL to comply with UL514A and/or UL514C and bear the UL Listing Mark. Devices shall also have been tested by UL and classified for fire resistance and bear the UL Classification Mark. Devices shall be classified for use in 1, 1-1/2, 2, 3-hour rated floors, or concrete floors with suspended ceilings. Fire resistive designs with suspended ceilings shall have provisions for accessibility in the ceiling below the poke-through device openings.

E. Poke-through device assemblies shall consist of an insert and an activation cover, as follows:

1. Insert: Insert body shall recess the devices a minimum of 2-3/4 inches (69mm) and have a polyester based backing enamel finished interior, ivory color. Furnish with necessary channels to provide complete separation of power and communication services.
   a. Six-inch diameter devices shall provide three (3) compartments that allow for up to three (3) duplex receptacles and/or twelve (12) communication ports.
   b. Eight-inch diameter devices shall provide five (5) compartments that allow for up to five (5) duplex receptacles and/or twenty-two (22) communication ports.
2. Body shall consist of an intumescent firestop material to maintain fire rating of the floor slab. Intumescent material shall not have to be adjusted to maintain fire rating of the unit and the floor slab.
3. Provide insert with a retaining feature to hold the poke-through device in the floor slab without additional fasteners.
4. Poke-through insert shall also consist of a 3/4-inch trade size conduit stub that is connected to the insert body and a 24.5 cubic inch stamped steel junction box for wire splicing and connections. Stamped steel junction box shall also contain the means necessary to electrically ground the poke-through device to the system ground.

F. Activation Covers: Manufactured of die-cast aluminum alloy, with powder coated finish available

in gray, black, brass, nickel or bronze. Finish shall be selected by Architect; standard selections shall be provided at no additional cost. Provide covers with two (2) gaskets (one for surface and one for flush) to go under the trim flange to maintain scrub water tightness. Covers shall have spring-loaded sides to allow cables to egress out of the unit and maintain as small an egress opening as possible.

G. Communication Modules and Mounting Accessories: Provide activation units with three locations to mount communication connectors. Mount connectors using a mounting bracket capable of accepting up to twelve (12) Ortronics TracJack Category 6 insert modules or TechChoice Category 6 discrete keystone connectors. Also provide units with two (2) Category 6 discrete keystone connectors and two (2) industry standard keystones and accommodate a mechanism to permit protection of communications cabling. Mechanism shall be fabricated from stamped steel and shall accept both flexible and rigid 3/4-inch, 1-1/4-inch, or 2-inch trade size conduit.

H. Basis of Design: Provide 6AT and 8AT series poke-through assemblies as manufactured by Legrand/Wiremold, or approved equal by listed manufacturer.

2.15. AUDIO/VISUAL WALL BOXES

A. Plated steel four-gang recessed wall boxes designed to provide power and cable management support for A/V equipment. Provide upper and lower chambers and mounting plates for A/V cable jacks. Coordinate mounting plate requirements with Owner's A/V Contractor. Upper chamber shall have 2" conduit knockout for A/V cabling.

B. Coordinate details with Architect and Owner.

C. Provide Legrand Wiremold Evolution Series Model EFSB4, or approved equal by FSR or Hubbell.

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 PVC)	Use PVC-coated RGS elbows to stub up through slab, unless 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	Schedule 40 PVC is acceptable for concealing grounding electrode conductors, except for plenum spaces. Provide RGS conduit where subject to physical damage.

APPLICATION	CONDUIT TYPE	REMARKS
Exterior underground.	RNC (Sched. 40 PVC)	PVC-coated RGS Elbows/Sweeps unless otherwise noted on the Drawings. Use PVC elbows for incoming electrical service.
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	
Corrosive locations (e.g. greenhouses).	Schedule 80 PVC	Provide PVC straps no more than 36" on center and stainless steel hardware.
Equipment connections in corrosive locations (e.g. natatoriums, greenhouses.)	LFNC	Short lengths only (maximum 6 feet). Use threaded rain-tight fittings and stainless steel hardware.

B. General Requirements

1. Provide hot-dip rigid Galvanized Steel Conduit (RGS) for exposed work in locations subject to physical damage and for work in damp/wet locations.
2. Provide hot-dip Rigid Galvanized Steel Conduit (RGS) with bonded PVC jacket (Plastic-Bond or Robr-Kap) elbows for bends below grade and where conduits turn up through slabs.
3. Aluminum conduit is prohibited.
4. All emergency system wiring shall be installed in a dedicated conduit system clearly identified as "Emergency".
5. MC cable shall be permitted for emergency and standby system wiring where concealed above accessible ceilings and/or within drywall partitions in accordance with the requirements of this Section".
6. 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.
7. All steel conduits below grade or in contact with earth shall have bonded PVC jackets.
8. Conduits shall slope from entrance equipment toward outside of building.
9. Provide non-metallic (PVC) conduit and fittings with stainless steel hardware in all corrosive environments, including but not limited to greenhouses, unless otherwise indicated.

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, and in floor slabs.

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 and exposed locations subject to damage 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 voltages are in 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 independent of conduit.

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. Communication System
2. Control Wiring
3. Emergency Lighting
4. Emergency Power
5. Fire Alarm System
6. Incoming Telephone Service
7. Incoming Electric Service
8. Incoming CATV Source
9. Lighting
10. Power 120/208 volt
11. Power 120/240 volt
12. Power 277/480 volt
13. Security System
14. Standby Lighting
15. Standby Power

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, wood, 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, wood, 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. Electric non-metallic Tubing (ENT) may not be used.

L. Communications, Control, 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.

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

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

O. 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.

P. 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.

Q. 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.

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

S. Complete raceway installation before starting conductor installation.

T. Support raceways as specified in Division 26 Section "Hangers and Supports". Arra[illegible]upport[illegible] prevent misalignment during wiring installation.

U. Use capped bushings or "push-penny" plugs to prevent foreign matter from ent[illegible]g the [illegible]nduit system during construction. Clean and plug or cap all conduits left emp[illegible]ture[illegible]

V. Protect stub ups from damage where conduits rise through floor sla[illegible] Arrange[illegible] curved portion of bends is not visible above the finished slab. Conduit stub-ups and s[illegible]down[illegible]shall be arranged in a neat and orderly manner and shall emerge at right angles[illegible] or [illegible]gs.

W. Make bends and offsets so the inside diameter is not redu[illegible] Keep le[illegible] of bends in the same plane and straight legs of offsets parallel, unless otherwise[illegible]dicate[illegible]

X. Use raceway fittings compatible with raceway[illegible]suitab[illegible]for use and location. For intermediate steel conduit, use threaded rigid steel cond[illegible]fittin[illegible]s[illegible]less[illegible]therwise indicated.

Y. Run concealed raceways, with a minimum [illegible]ends, [illegible]the shortest practical distance considering the type of building construction and obstructi[illegible]ess otherwise indicated.

Z. Conduits may be installed in[illegible]oncre[illegible]floor slabs with the following limitations:

1. Maximum size –2
2. Minimum[illegible]te co[illegible]– 1", above and below.
3. Minimu[illegible]spacin[illegible]etwe[illegible]conduits - 6" on center.
4. Condu[illegible]outside di[illegible]eter - 1/3 of slab thickness, maximum.
5. Install[illegible]between [illegible]ttom and top reinforcing, and centerline of conduit at the mid-depth of [illegible]e slab.
6. Secur[illegible]to prevent possible change in position, sagging, or shifting as concrete is poured.
7. W[illegible]r or damp-proofing integrity of slab is not disturbed.
8. [illegible]nduits larger than 1-1/4" may be installed in [grade level] concrete floor slabs only with t[illegible]ecific 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.

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

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

CC. 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.

DD. 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.

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

FF. 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.

GG. Stub up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plug 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.

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

II. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

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

KK. All metal raceways for circuits over 250-volts to ground shall be bonded per NEC Article 250.97.

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

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

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

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

PP. Conduit surfaced 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.

QQ. 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.

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

SS. 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.

TT. 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.

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

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

WW. 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.

XX. 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.

YY. 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.

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

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

BBB. No running threads shall be cut or used.

CCC. Conduits which are installed at the time and left empty for future use and which are five feet or more in length, including all 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.

DDD. In all instances where flush mounted type panelboards are installed, provide spare (empty) conduits in accordance with schedule in Division 26 Section "Panelboards", Paragraph "Provision for Future Circuits at Flush Mounted Panelboards". These conduits shall extend between the panelboard cabinet and a junction box located above accessible ceiling construction.

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.

Set floor boxes level and adjust to finished floor surface.

C. 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.

D. 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.)

E. 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.

F. 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.

G. 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.

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

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

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

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

L. Outlet boxes and covers shall be of proper Code size for the number of wires and/or conduits passing through or terminating therein, as well as the quantity, type, and dimensions of wiring device(s) installed therein. In no case shall any box be less than 4" square. Special attention shall be paid to boxes with deep wiring devices, E.G., GFCI receptacles, USB charger receptacles, and network lighting switches, etc.

M. Outlet boxes for switches shall be one gang type.

N. Each circuit in each pull box 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 knock-out 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 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 square 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 against the wire protection shoulder. Where chase nipples are used, align 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 box, conductors shall be protected by an insulated bushing providing a smoothly rounded surface.

E. Water tight hubs shall be used at termination of rigid conduit 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 detailed in Division 26 Section "Common Work Results for Electrical".

C. Provide Liquidtight Flexible Nonmetallic Conduit (LFNC) in short lengths (maximum 6 feet) for the final connection of equipment in corrosive locations (e.g. natatoriums, chemical storage rooms, greenhouses, etc.).

D. 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.

E. Flexible connections shall be sized per the Contract Drawings, or as required in accordance with Code; the more stringent requirement shall apply.

F. Provide extra flexible VFD cable for VFD output circuits as specified in Division 26 Section 260519, "Low-Voltage Electrical Power Conductors and Cables".

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 Architect.

B. All exposed conduit, boxes, equipment, etc. in interior 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.

D. All exposed conduit, boxes, equipment, etc. on the stage, shall be painted flat black.

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 conduit, the entire run to the nearest box or other termination point shall be cleaned.

END OF SECTION 260533

SECTION 260535 – RACEWAY AND BOXES FOR LOW-VOLTAGE SYSTEMS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

A. Drawings and General Provisions of the contract, including general and Supplementa[l] Condi[tions] and Division 01 Specifications apply to this Section.

1.2. SUMMARY

A. This section includes requirements for miscellaneous raceway systems [for] the f[ollo]wing:

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, and boxes, as [indi]cated on the technology and security contract drawings to form empty raceway systems.

B. Equipment and wiring wi[ll be] installed under separate contract by Owner's Special System Contractors Divisi[on] and Di[vis]ion 28 unless otherwise indicated on the Contract Drawings or in another Section [of] these S[pecif]ications.

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. [O]UTLET 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 box 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. FLOOR BOXES

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

2.5. AUDIO/VIDEO WALL AND/OR CEILING BOXES

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

2.6. COVER PLATES

A. Device plates will be provided under Division 27 and Division 28.

PART 3 - EXECUTION

3.1. INSTALLATION

A. Provide all raceway components, as required, for complete system. Extend conduits and/or surf raceways to nearest accessible ceiling space for devices with connections within the spac and the nearest accessible corridor ceiling space for connections/cabling back to the MDF or IDF m, unless otherwise noted on the drawings.

B. Each run of conduit shall contain no more than two 90 degree bends and no run ll ex d 100 ft. in length. Minimum radii for bends: 10 1/2" for 1" conduit, and a minimum of te mes trade size diameter bends for larger sizes. Do NOT use conduit fittings in lieu

C. Provide insulating bushings on all conduit terminations.

D. Provide pullboxes in conduit runs exceeding 100 feet (30 m) h, a uns with more than two right angle bends. Do NOT use conduit fittings in lie bends.

E. Identify all cabinets, and pull and junction boxes as ystem age

F. Provide nylon pull cord in each conduit run.

G. Provide identification tags on all conduit s.

H. Provide cover plates on all outlet boxes.

I. Provide plywood backboard nd du ex receptacles in equipment room(s). Confirm location on job site prior to installation. nt all boards with prime coat of fire resistant paint and finish coat of enamel in color to match In unfinished rooms, provide gray finish coat.

J. Coordinate all w k with ner, wner's Special System Contractors and Division 27 and Division 28 Contractors

END OF SECTIO 260535

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 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 existing 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. In 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 of 5 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, handholes, and manholes.

1.6. SITE CONDITIONS

A. General: Clearing work shall not begin until temporary fences, barricades, warning [illegible] 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 paved ways carrying public traffic, the equipment whether empty or loaded, shall in all cases yield to public traffic.
7. Supply and maintain barricade 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 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 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 welded connections and shall provide a water-tight joint.

2. Concrete: Comply with ACI 318 -- 3,000 PSI strength in 28 days.

a. Cement: Portland Blast-Furnace Slag Cement, Type IS or equal meeting ASTM C593M Specifications and the requirements of ACI 318 and 301.
b. Fine Aggregate: Concrete sand meeting requirements of ASTM C33.
Coarse Aggregate: ASTM #57 crushed limestone, meeting requirements of ASTM C33.
d. Air Entraining Admix: Complies with ASTM C260 Standard Specifications for Air Entraining Admixtures for Concrete.
e. Water: Complies with ASTM C94 Standard Specifications for Ready-mixed Concrete.

3. Use pea gravel aggregate for void-free duct penetration.
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.
5. 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.
6. Joint Sealant: Watertight as recommended by conduit manufacturer.
7. Cable Sealing Bushings: OZ type CSB, with PVC coated discs, or equal.
8. Thruwall and Floor Seals: OZ type FSK or WSK, or equal.
9. Expansion Joints: Expansion joints shall be Dylite, as manufactured by Copper, Scorogord, or Dow Chemical and shall conform to ASTM D-1752, Type II.
10. 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 ends 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 manholes and electrical distribution equipment, e.g. transformer(s)].

I. Drainage Assembly: All ducts shall drain to an open end away from the building or electrical equipment. Ducts shall drain towards manhole(s) and 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 260553, “Identification for Electrical Systems” for product requirements.
2. Bury underground line warning tape 12-inches below grade above every ductbank and buried conduit.

2.4. TEST PITS

A. Provide test pits to locate all utilities and structures. Provide test pits as necessary to determine actual locations and profiles of obstructions to proposed new work.

B. Verify existing utilities, locations, and inverts and points of connection.

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 locating 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.

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. Concrete envelope: 3 inches minimum beyond surface of any conduit, minimum 2 inches between conduits. Top of ductbank shall be crowned to prevent puddling of water.

D. Seal and Thru Wall Fittings: At entrances to buildings for watertight construction.

E. 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.

F. Mandrel conduits: Mandrel 12 inch long, 1/4 inch less than conduit I.D. Draw a testing mandrel through each duct.

G. Clean conduits: After mandrel, with stiff brush, leave no particles or debris. Immediately install end plugs after cleaning.

H. 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.

I. Stagger vertical conduit joints: Minimum 6 inches. All joints shall have couplings installed.

J. 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 respectiv utility, vaults, and buildings, etc. Rebar shall not be installed less than 2-inches from sides of a duct.

3.3. EXCAVATION, BACKFILLING, COMPACTING, AND SITE PREPARATION

A. Provide all excavating and backfilling and site preparation necessary to all 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 mon Work Results for Electrical".

B. Install forms on sides of the ductbank if the trench is not of the proper ness to prevent cave-in. Provide all required excavating, shoring, sheeting, bracing, a filling

C. The bottom of the trench shall be undisturbed earth. If the ch botto is too low for proper grade, fill to the proper level with sand and mechanically c pact Cut t nches neatly and uniformly.

D. Each excavated section between utility hol d fro tility holes to the building shall be completely excavated and graded before a duct in t t section.

E. Provide underground line warning tape 12-i s belo finished grade over all ductbanks. Refer to Division 26 Section "Electrical Identification duct requirements.

F. Excavation and Backfill: R er to vision 26 Section "Common Work Results for Electrical".

G. After excavation of the trenc es shall be driven in the bottom of the trench at four-foot intervals to establish the grad rout the duct bank.

H. Pitch the trench uniform towards utility holes or both ways from high points between utility holes for the re ed duct l e drainage. Avoid pitching ducts towards buildings wherever possible.

I. The ls of th trench may be used to form the side walls of the duct bank provided that the soil is self-s ort g and that concrete envelope can be poured without soil inclusions. Forms are require ere 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. tore 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 conduits by either method, all existing paved or grass areas which have been disturbed in any way shall be restored to their original conditions.

C. Work with extreme care near existing ducts, conduits, cables, and other utilities to avoid damaging them.

3.5. PLACEMENT OF CONDUIT

A. Within five (5) feet of each existing building wall, utility hole penetration, install heavy wall galvanized steel conduit within the concrete envelope to provide protection against vertical shearing.

B. Core drill all walls, footings and utility holes and make watertight per Division 26 using an assembly of rubber links of mechanical seal of the proper size for each pipe and tighten in place, in accordance with the manufacturer's instruction, after the heavy conduit is installed.

C. 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 complete 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.

D. Pitch conduit properly for drainage to manholes and handholes and to prevent low pockets or irregular dips between conduit ends. Minimum pitch to be 4 inches per 100 feet.

E. Provide accurate locations of conduit in utility hole.

F. Depending on encasement necessary for duct formation, place conduits on spacers. The minimum encasement thickness 1-1/2-inches on all sides.

G. Lay conduits using spacers to provide tier spacing.

H. 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.

I. 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.

J. 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.

K. Provide end bells on ducts at utility holes. End bells shall be a pre-manufactured system (system manufactured by Formex or equal) with conduit seals and provisions for roughing into the concrete.

L. Provide insulated, grounding bushings on duct ends in equipment enclosures.

M. Plug or cap empty conduits. Provide standard manufactured plugs.

N. Seal all ducts and conduits, at both ends with foam duct seal to prevent entrance of moisture and gases. Refer to Division 26 Section "Common Work Results for Electrical" for product requirements.

O. 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.

P. Clear conduit by rod and pull an approved test mandrel from structure to structure or from structure to the conduit termination.

Q. Leave nylon or polyester pull line in each conduit, tagged to identify the conduit's point of origin, contents and final destination.

R. 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 sag 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.

S. 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.

T. Install top of duct bank minimum 30 inches below finished grade.

U. 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 conduit 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. CONCRETE WORK

A. Unless otherwise indicated, all concrete work for electrical ductbanks, etc., shall be provided under this section of the work. All concrete shall have a minimum 3,000 psi compressive strength at 28 days. Concrete for ductbanks shall be Class B, 470 lb. Portland cement per cubic yard.

B. Supervise the placement of concrete in the duct bank.

C. Complete entire section of conduit from utility hole to manhole or from manhole [utility pole to building] to building before encasement by concrete. The entire conduit system shall be tied together with wire and anchored to the bottom of the trench to prevent any movement or floating while pouring concrete.

D. Place concrete as specified in Section. Top of concrete envelopes shall be not less than 24 inches below grade.

E. Provide a minimum of 3-inches (76mm) of concrete cover over conduit at the top, bottom, and sides of the duct bank. Provide crowned top on the concrete to prevent water accumulation. At poured manholes, tie duct and manhole reinforcing steel together to provide a permanent connection.

F. Place concrete continuously from [manhole to manhole] [utility pole] to building without interruption.

G. Extend concrete envelope to finish floor grade or interior wall surface in buildings at finish pad grade at equipment. Maintain moisture seal.

H. Conduits in completed ductbanks shall be straight to within 1/4 inch per 100 feet in both vertical and horizontal directions.

I. Pull solid mandrels and swabs (diameter 1/4 inch smaller than conduit) through each conduit in completed ductbank before installing cables.

J. Concrete-Encased Nonmetallic Ducts: Support on plastic separators coordinated with duct size and required duct spacing, and install according to the following:

1. Separator Installation: Space separators close enough to prevent sagging and deforming

of ducts, and secure separators to the earth and to ducts to prevent floating during concreting.

a. Do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups. Provide nonferrous tie wires to prevent displacement of the ducts during pouring of concrete.
b. Provide spacers staggered at least 6 inches vertically along the length of the duct run to eliminate the potential for a weak vertical shear plane in concrete encasements.
c. Provide a minimum of four spacers per 20-foot interval (5 feet maximum) of the length of the duct run.

2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not use power driven vibrating equipment unless specifically designed for duct bank application. Pour each run of envelope between manholes or other terminations in one continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (18mm) reinforcing rod dowels extending 18 inches (450 mm) into the concrete at both sides of joint near the corners of the envelope.
3. Reinforcing: Provide reinforcing steel bars at the top and bottom of each concrete envelope as shown on Drawings and at the present and indicated future locations, including but not limited to the following:

a. Crossing fill or loose soil (4 feet beyond the exterior limits on each side).
b. Crossing other utilities (as beyond the exterior limits on each side).
c. Entering buildings, manholes, vaults, etc. (20 feet beyond).
d. Crossing vehicular roadways and parking areas (underneath and 20 feet beyond the exterior limits on each side).
e. Rebar shall not be installed less than 2-inches from the sides of any duct.
f. Under all pavement (20 feet beyond edge of pavement).
g. Crossing soft and rock where the bottom of the trench is not undisturbed soil or where bearing is less than 3,000 psf, then the entire distance such conditions exist, plus 10 feet either side of these conditions.

4. Forms: Use the walls of the trench to form the side walls of the duct bank where the soil is self supporting and concrete envelope can be poured without soil inclusions. Otherwise, use forms.
5. Minimum Clearances Between Ducts: Three inches (75 mm) between ducts and exterior envelope wall, 3 inches (75 mm) between ducts for like services, and 6 inches (150 mm) between power and signal ducts. Provide plastic spacers to maintain clearances.
6. Depth: Except as otherwise indicated, install top of duct bank at least 30 inches (750 mm) below finished grade in nontraffic areas and for 600 volts and below. Install at least 36 inches (900 mm) below finished grade in vehicular traffic areas and for 600 volts and above.

K. Partial Pouring: Each run of envelope between utility holes shall be poured in one continuous operation. Where more than one pour is necessary, each pour shall terminate in a vertical plane, and 3/4-inch reinforcing rod dowel extending 18 inches into the concrete on each side of the joint shall be provided. The number and locations of dowels shall be as approved. Partial pours shall not terminate in horizontal or angular planes.

L. Extensive Disturbed Earth: Where an envelope is installed over an extensive area of disturbed earth, such as that within the periphery of the building, a separate 3,000 psi concrete base, satisfactory, shall be provided to ensure stability of the conduits during installation. The base shall be allowed to set before the conduit bank is installed.

M. Obstructions Below Grade: Where an envelope is installed over disturbed earth, across other conduits or pipe lines or under roads or driveways, it shall be reinforced. Reinforcement shall also be provided where envelopes connect to manhole and building walls, to prevent shearing of the joints. Where envelopes are terminated for future extension, dowels shall be provided as specified above for joints between pours. Reinforcement, generally, shall consist of 3/4-inch rods located in a single layer 1-1/2 inches above the bottom of the envelope. Outside rods shall be located 1-1/2 inches in from the outside edges of the envelopes and an intermediate rod shall be placed in the center of each space between conduits in the lowest row. Provide No. 4 steel reinforcing bars on top of envelope under paved areas. Additional reinforcement shall be furnished as directed following an inspection of the trench.

N. Stub-Ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete pads, extend steel conduit a minimum of 5 feet (1.5m) from the edge of the pad and 5 feet outside of the building foundation. Install insulated grounding bushings on the terminations. Couple steel conduits to the ducts with adapters designed for the purpose and then encase coupling with 3 inches (75 mm) of concrete. Provide insulated grounding bushings on the terminations.

O. Above-Grade Conduit

1. All exposed conduit rising more than one foot (1') above the adjacent grade shall be rigid steel conduit, full weight, pipe size, finished inside and outside by a hot-dipped galvanized method. Conduit shall have threaded type couplings and fittings with insulated end bushing. Rigid steel conduit shall extend a minimum of eighteen inches (18-inches) below grade before transition to PVC conduit.
2. Provide galvanized or cadmium-plated nails, screws, clips, or other means of securely anchoring conduit to buildings or other structures as required for a complete installation. Adequate provisions shall be taken to prevent dielectric action between dissimilar metals.

P. Sealing: Provide temporary closures at terminations of ducts that are wired under this project. Seal spare ducts at terminations. Use foam duct sealant as specified in Division 26 Section 260500, "Common Work Results for Electrical".

Q. Building Entrances: Transition from underground duct to conduit 10 feet (3m) minimum outside the building wall. Use fittings manufactured for the purpose. Follow appropriate installation instructions below:

1. Concrete-Encased Ducts: Install reinforcing in ductbanks passing through disturbed earth near buildings and other excavations. Coordinate ductbank with structural design to support ductbank at wall without reducing structural or watertight integrity of building wall.
2. Waterproofed Wall and Floor Entrances: Install a watertight entrance-sealing device with the sealing gland assembly on the inside. Anchor device into masonry construction with 1 or more integral flanges. Secure membrane waterproofing of the device to make permanently watertight.

R. Mandrelling: After concrete envelopes have set, all conduits shall be mandrelled to ensure smooth interior surfaces free from burrs or obstructions that might damage the conductor Insulation or sheaths.

3.7. 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 tape 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 conduits shall be opened from manhole to manhole or manhole to building prior to placing 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 clean-up.

H. Separation distance from other buried utilities as follows:

1. Insulated Steam: 24-inches.
2. Un-insulated Steam: 48-inches.
3. All others: 18-inches.

3. DIRECT BURIED CONDUIT

A. Provide where indicated direct-buried electrical circuits utilizing either PVC Schedule 40 or PVC-coated rigid galvanized steel 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 yellow plastic 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. Provide through-wall fittings on all wall penetrations.

E. Where an underground conduit, without a concrete envelope, enters the building through a 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 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 where elevations between intervals is different by 2 feet or more between data points.

B. Provide record drawings indicating actual locations of all installed ductbanks, handholes and manholes, including elevations. The record drawings shall indicate location, elevation, and type of service for all utilities crossed by each 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 260500, "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 260543

SECTION 260545 – 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 indicated.

1.3. RELATED WORK

A. Related Sections include the following:

1. Division 26 Section 260500, "Common Work Results for Electrical" for excavation and backfill requirements.
2. Division 26 Section 260519, "Low-Voltage Electrical Power Conductors and Cables" for conductors installed in raceways and boxes and conductor terminations.

1.4. QUALITY ASSURANCE

A. Manufacturer Qualifications: Firm experienced in manufacturing underground precast concrete utility structures of types and sizes required and similar to those indicated for this Project. Firm must have a minimum of a 5-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.

Coordinate layout and installation of conduits and handholes with final arrangement of other utilities as determined in the field.

E. Coordinate elevations of conduit 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:

a. ANSI/SCTE 77 2007.
b. ASTM D-543, D-570, D-756, D-2444, G-154.
c. National Electrical Code, NFPA-70.
d. Underwriter's Laboratory (UL).

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.

D. Submit Site Shop Drawings indicating the proposed location of all handholes. Proposed deviations from the Contract Drawings shall be clearly marked on the Submittals. Shop Drawings shall indicate coordination with other utilities and underground structures. Include plans and sections drawn to accurate scale.

E. Submit manufacturer's installation instructions under provisions of General Conditions of the Contract.

F. Submit Shop Drawings, including the following:

1. Drawings for each size and configuration of precast handhole with details of accessories and joints.
2. Drawings showing size, shape, configuration and identification of all cover plates and their legends.

1.6. PROJECT RECORD DOCUMENTS

A. Submit and 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

Deliver, store, protect, and handle products to site under provisions of Division 26 Section 260500, "Common Work Results for Electrical".

B. Accept products on site. Inspect for damage.

C. Store precast concrete units at site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

D. 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 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 PULLBOXES

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

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 Rubbe

PART 3 - EXECUTION

3.1. EXCAVATION

A. Provide responsibility for all demolition, excavation and backfilling required to install hand holes.

B. After completion of utility hole installation, return all ground and pavement surfaces to original condition or to condition as indicated on the drawings. This includes all sidewalks, curbs, lawns, etc.

3.2. INSTALLATION

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. Conduit penetrations shall be sealed with grout or waterproof sealant. All conduit ends shall have nylon or plastic bushings to prevent damage to insulation when pulling.

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. 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. Take all necessary precautions to avoid the flooding of handholes and conduits. If the handholes or conduits should become flooded or littered with debris any time prior to final acceptance, pump out and clean handholes and conduits to the satisfaction of the Engineer.

D. Clean-Up: Remove debris from handholes and ensure complete installation is left in neat and finished condition.

END OF SECTION 260545

SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SUMMARY

A. This Section includes 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.

B. Schedule of Nomenclature: An index of electrical equipment and system components used in identification signs and labels. Provide schedule of nameplates.

C. Samples: Prior to installation, submit samples for each type of label and sign to illustrate color, lettering style, and graphic features of identification products. These samples shall include examples of the lettering to be used. Samples shall be mounted on 8-1/2-inch x 11-inch sheets annotated, explaining their proposed use.

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 len 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 ders.
3. Emergency circuits shall also have legend to read “EMERGENCY”.

B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend, inate with a clear, weather- and chemical-resistant coating.

C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color- ed, a lic band sized to suit the diameter of the line it identifies and arranged to stay i pre ned gripping action when placed in position.

D. Colored Adhesive Tape: Self-adhesive vinyl tape less 3 s thick by 3/4 inch wide, in appropriate colors for system voltage and phase.

E. Tape Markers: Vinyl or vinyl-cloth, self- esiv paro id type with preprinted numbers and letters.

2.2. WIRING DEVICE FACEPLATE LABE

A. Adhesive Labels:

1. Thermal t print e, clear polyester material with glossy finish, 1/2" high, width as require Printed tteri shall be 1/4" high black text.
2. Label hall be bac d with permanent acrylic adhesive and shall exhibit good adhesion to m ny al and ot r types of surfaces, including textured surfaces and low surface energy lastics.
3. Label shall be resistant to humidity, temperature and UV light.
4. La s shall meet requirements of UL 969 Labeling and Marking Standard and shall be HS compliant.
5. P de Brady B-432 Series, or approved equal by acceptable manufacturer.

. Factory Labeled Faceplates:

Faceplates for devices on emergency circuits shall be factory-engraved to read “EMERGENCY”. Refer to Division 26 Section, “Wiring Devices” for additional information.

2. Faceplates for devices on GFCI-protected circuits shall be factory engraved to read “GFCI”. Refer to Division 26 Section, “Wiring Devices” for additional information.

.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, unless otherwise required by the Authority Having Jurisdiction (AHJ).
c. Standby Power System: White lettering on purple background, unless otherwise required by the Authority Having Jurisdiction (AHJ).

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.
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. Electrical ducts, piping or cable (above 600V) - Red tape with black printed labeling: CAUTION –BURIED HIGH VOLTAGE CABLE BELOW.
3. Telephone conduits or cable - Orange tape with black printed labeling: CAUTION - BURIED TELEPHONE LINE BELOW.
4. Communications Conduits or Cable – Orange tape with black printed labeling: CAUTION – BURIED COMMUNICATIONS LINE BELOW.
5. Fiber Optic conduits or cable - Orange tape with black printed labeling: CAUTION - BURIED FIBER OPTIC LINE BELOW.
6. 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 260543, "Underground Ducts and Raceways for Electrical Systems" 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 piece of equipment, including but not limited to, switchboard(s), 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 directories 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 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/labels parallel to equipment lines.
7. Install nameplates/labels on equipment fronts/covers unless otherwise noted.
8. Install nameplates/labels on inside face of equipment door/cover, including junction boxes, where exposed in finished spaces.
9. Secure nameplates to inside of recessed panelboards in finished locations.
10. Embossed tape will not be permitted for any application.
Stenciling is prohibited.
12. Labels: All labels shall be permanent and be machine-generated. NO HANDWRITTEN OR NON-PERMANENT LABELS SHALL BE ALLOWED.
13. 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 sheath. 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 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.
4. The circuit directories shall include the name, address, and contact information for the Electrical/Division 26 Contractor.
5. If at any time 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, 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. Caution Labels for Boxes and Enclosures: Provide pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background.

J. Circuit Identification Labels on Boxes:

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.

K. 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.

L. Secondary Service, Feeder, and Branch-Circuit Conductors: Color-code throughout the secondary electrical system. Refer to Division 26 Section 260519, “Low-Voltage Electrical Power Conductors

and Cables" for additional requirements.

M. 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.

N. 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 consistent system of tags, color-coding, or cable marking tape.

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

1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
2. Emergency Operations: Install engraved laminated signs with white legend on red background with minimum 3/8-inch- (9-mm-) high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

P. 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. Switchboards.
c. Transformers.
d. Disconnect Switches.
e. Enclosed Circuit Breakers.
f. Motor Controllers.
g. Generators.
h. Transfer Switches.
i. Electrical Cabinets and Enclosures.
j. Lighting Control Panels.
k. Fire Alarm Control Panel.
l. Access Doors and Panels for Concealed Electrical Items.
m. Variable Speed Drives Elevator Control Switches.

Q. 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 on 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.
c. At each end of the above series, markers provide a pipe banding tape around the conduit. Refer to paragraph "Color Code Banding and Painting of Raceways, Boxes, and Cables" in part 3 of this Section for banding requirements.

R. 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.

S. Provide NEC, ANSI, and OSHA approved DANGER - HIGH VOLTAGE warning signs on all doors of dedicated electrical rooms or closets. Where doors are located in finished areas, locate sign on the inside of the door. Coordinate mounting requirements with the Engineer. Minimum sign dimensions shall be 7-inch x 11-inch.

T. Surfaces shall be cleaned and painted, if specified, before applying markings.

U. Place markers 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 260553

SECTION 260573 – OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

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. ALLOWANCES

A. Refer to Division 01 Section, "Allowances" for description of work under this Section affected by Allowances.

1.3. SCOPE

A. An Engineering Analysis and Coordination Study shall be performed on and include all portions of the electrical distribution system. The analysis shall include a short-circuit analysis with protective device evaluation, a protective device coordination study, time-current analysis of each protective device, and equipment evaluation study.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in the current version of NFPA 70E – Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584-2002, the IEEE Guide for Performing Arc-Flash Calculations.

C. The project/report shall begin at the overcurrent protective device ahead of the new pad-mounted transformer, to the 480/277V main switchboard (MSB) and continue through the 480/277V and 208/120V distribution systems to the new branch panelboards, including dry-type transformers. Report shall also include on-site emergency/standby power supply system, including the on-site generator, transfer switch(es), and associated electrical distribution equipment.

1.4. REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

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

B. American National Standards Institute (ANSI):

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

C. The National Fire Protection Association (NFPA)

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

1.5. SUBMITTALS

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

B. The results of the short circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. A minimum of five (5) bound copies of the complete final report shall be submitted. Electronic PDF copies of the report shall be provided upon request.

C. The report shall include the following sections:

1. Executive Summary including Introduction, Scope of Work and Results/ Recommendations.
2. Short-Circuit Methodology Analysis Results and Recommendations.
3. Short-Circuit Device Evaluation Table
4. Protective Device Coordination Methodology Analysis Results and Recommendations.
5. Protective Device Settings Table
6. Time Current Coordination Graphs and Recommendations
7. Arc Flash Hazard Methodology Analysis Results and Recommendations including the details of the incident energy and flash protection boundary calculations, along with Arc Flash boundary distances, working distances, Incident Energy levels and Personal Protection Equipment levels.
8. Arc Flash Labeling section showing types of labels to be provided. Section will contain descriptive information as well as typical label images.
   One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis.

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 Engineer and Owner, and other information specified.

1.6. QUALITY ASSURANCE

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the responsible charge and approval of a Registered State of Delaware Professional Electrical Engineer skilled in performing and interpreting the power system studies. Report shall be signed and sealed by the Engineer on each page**.**

B. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

C. The approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analyses it has performed in the past year.

D. Engineering Analysis and Coordination Study shall be performed by one of the following, or an approved and qualified equal.

1. Cable Testing Services, Inc.
   505 School House Road
   Kennett Square, PA 19348
   Telephone: 302-369-5420
   Fax: 302-369-5515
   Contact: Chris Fultz
2. AB Engineering LLC
   303 Dressage Court
   West Chester, PA 19382
   Telephone: 610-765-1290
   Fax: 610-785-1319
   Contact: Alton Bau[illegible] P.E.
3. Potomac Testing [illegible]c.
   1610 Professional [illegible]d Suite [illegible]
   Crofton, MD 21114
   Telepho[illegible]: 301[illegible]2-19[illegible]
   Toll-F[illegible]e: 1-800-[illegible]-2022
   Conta[illegible] Paul Gil[illegible].E.
4. [illegible]oordi[illegible]d Pow[illegible] Engineering, Inc.
   1340-C Cha[illegible]wood Road
   Ha[illegible]ver, MD 21076
   [illegible]ephone: 410-694-9494
   [illegible] 410-694-0085
   Contact: Carl E. Rager, P.E.
5. Keystone Engineering Group, Inc.
   590 East Lancaster Avenue, Suite 200
   Frazer, PA 19355
   Telephone: 610-407-4100
   Fax: 610-407-4101
   Contact: Philip M. Gonski, P.E.
6. IETC
   5410 Mt. Pigsah Road
   York, PA 17406
   Telephone: 717-252-4730
   Fax: 717-252-4793
   Contact: William N. Luddy, P.E.
7. Reuter Hanney
   11620 Crossroads Circle
   Suite D-E
   Middle River, MD 21220

Telephone: 410-344-0300
Fax: 410-335-4389

8. Schneider Electric
9 East Court, Suite G
Owings Mills, MD 21117
Telephone: 410-559-2917

PART 2 - PRODUCTS

2.1. STUDIES

A. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E – Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D. The study shall also include short-circuit and protective device coordination studies.

2.2. DATA

A. Contractor shall furnish all data as required for the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a list of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source contribution may include present and future motors.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor.

D. If applicable, include fault contribution of existing motors in the study. The contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3. SHORT-CIRCUIT ANALYSIS

A. Transformer design impedances shall be used when test impedances are not available.

B. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities.
3. One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.
4. The study shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
5. Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating.

6. Results, conclusions, and recommendations. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.

C. For solidly-grounded systems, provide a bolted line-to-ground fault current study for applicable buses as determined by the engineer performing the study.

D. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings.
2. Adequacy of switchgear, motor control centers, and panelboard bus bars with respect to thermal and short-circuit stresses.
3. Contractor shall notify Engineer in writing, of any circuit protective devices improperly rated for the calculated available fault current.

2.4. PROTECTIVE DEVICE TIME-CURRENT COORDINATION ANALYSIS

A. Protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title with descriptive device names.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable.

1. Electric utility overcurrent protective device
2. Medium voltage equipment overcurrent relays
3. Medium and low voltage fuses including manufacturer's minimum emtl, total clearing, tolerance and damage bands.
4. Low-voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.
5. Transformer full load current, magnetizing inrush current, and ANSI through fault protection curves.
6. Medium voltage conductor damage curves.
7. Ground fault protective devices, as applicable.
8. Pertinent motor starting characteristics and motor damage points, where applicable.
9. The largest feeder circuit breaker in each applicable panelboard.

Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

. Provide the following:

1. A one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.
2. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
3. Computer printouts shall accompany the log-log plots and will contain descriptions for

each of the devices shown, settings of the adjustable devicse, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.

4. The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation where the devices is located, and the device number corresponding to the device on the system one-line diagram
5. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.
6. Contractor shall notify Engineer in writing of any significant deficiencies in protection and/or coordination. Provide recommendations for improvements.

2.5. ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA 70E-2009, Annex D. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis (Section 2.03) and the protective device time-current coordination analysis (Section 2.04).

B. The flash protection boundary and the incident energy shall be calculated at all locations in the electrical distribution system (distribution panelboard, branch panelboards) where work could be performed on energized parts.

C. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.

D. When appropriate, the short-circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

E. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications.

F. The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 5 cycles.

H. For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for

the front cubicles and shall be based on the equipment's main device to clear the arcing fault. For all other non-ANSI rated equipment, only one calculation shall be required and it shall be based on a device located upstream of the equipment to clear the arcing fault.

I. When performing incident energy calculations on the line side of a main breaker (as required above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be check amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584-2018 section 4.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

L. Provide the following:

1. Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, personal protective equipment classes and AFIE (Arc Flash Incident Energy) levels.
2. The Arc Flash Hazard Analysis shall report incident energy values based on recommended device setting for equipment within the scope of the study.
3. The Arc-Flash Hazard Analysis must include recommendations to reduce AFIE levels and enhance worker safety.
4. The Arc-Flash Hazard Analysis shall also include copies of arc-flash hazard warning labels specified in Part 3 of this Section, for all pieces of equipment receiving a label, which shall also be included in the O & M Manual specified in Division 01.

PART 3 - EXECUTION

3.1. FIELD ADJUSTMENT

A. Contractor shall adjust relay and protective device settings according to the recommended setting table provided by the coordination study.

B. Contractor shall make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Contractor shall notify Engineer in writing of any required major equipment modifications.

3.2. ARC FLASH HAZARD LABELS

A. Contractor shall provide a 4.0 in. x 4.0 in. (nominal) Brady thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The labels shall be designed according to the following standards:

1. UL969 – Standard for Marking and Labeling Systems
2. ANSI Z535.4 – Product Safety Signs and Labels
3. NFPA 70 (National Electrical Code) – Article 110.16

C. The labels shall include the following information:

1. Equipment Designation
2. Source Designation
3. Fault Current (kA)
4. System Voltage
5. Flash Protection boundary
6. Personal Protective Equipment category
7. Arc Flash Incident energy value (cal/cm2)
8. Limited and restricted Approach Boundaries
9. Study report number and issue date
10. Name of Company who completed study

D. Labels shall be printed by a thermal transfer type printer, with no field marking.

E. Arc flash labels shall be provided for equipment as identified in the study and the respective equipment access areas per the following:

1. Floor Standing Equipment – Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided on each individual section access area. Equipment such as switchgear, uninterruptible power supply systems containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.
2. Wall Mounted Equipment – Labels shall be provided on the front cover or a nearby adjacent surface, depending upon the equipment configuration.
3. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.

F. Labels shall be field installed by Contractor.

3.3. AVAILABLE FAULT CURRENT LABELS

A. Contractor shall provide a 4.0 in. x 4.0 in. Brady thermal transfer type label of high adhesion polyester for each switchboard and panelboard to identify the maximum available fault current at the equipment in accordance with the National Electrical Code Article 408.6.

B. The labels shall be designed according to the following standards:

1. UL969 – Standard for Marking and Labeling Systems
2. ANSI Z535.4 – Product Safety Signs and Labels
3. NFPA 70 (National Electrical Code) – Article 110.24.

C. The labels shall include the following information:

1. Line 1 – "Maximum Available Fault Current"
2. Line 2 – "_____ Amperes"; Contractor shall field mark maximum available fault current available at the line terminals of the equipment.
3. Line 3 – Date of Installation

D. Labels shall be printed by a thermal transfer type printer.

E. Labels shall be field-installed by the Contractor.

END OF SECTION 260573

SECTION 260800 – COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SUMMARY

A. This Section includes requirements for commissioning the electrical systems and its subsystems and equipment. This Section supplements the general requirements specified in Division 01 Section "General Commissioning Requirements."

B. Related Sections include the following:

1. Division 01 Section "General Commissioning Requirements" for general requirements for commissioning processes that apply to this section.

C. The following systems and/or equipment shall be commissioned:

1. Emergency/Standby Power Supply System
    a. Generator
    b. Transfer Switch(es)
2. Lighting Control System(s)
    a. Network control system
3. Broadcast Lighting System
    a. Theatrical lighting fixtures
    b. Lighting controls

1.3. DEFINITIONS

A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of electrical systems, electrical, communications, and other related systems.

B. CxA: Commissioning Authority.

C. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

1.4. CONTRACTOR'S RESPONSIBILITIES

A. The following responsibilities are in addition to those specified in Division 01 Section "General Commissioning Requirements."

B. Electrical Contractor:

1. Provide certified and calibrated measuring instruments and logging devices to record test data, and data acquisition equipment to record data for the complete range of testing for the required test period.

C. Electrical Contractor:

1. With the Mechanical Contractor, coordinate installations and connections between and among electrical and HVAC systems, subsystems, and equipment.
2. Attend TAB verification testing.

1.5. COMMISSIONING DOCUMENTATION

A. The following are in addition to documentation specified in Division 01 Section "General Commissioning Requirements."

B. Test Checklists: CxA with assistance of Contractor shall develop test checklists for electrical systems, subsystems, and equipment, including interfaces and interlocks with other systems. CxA shall prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. In addition to the requirements specified in Division 01 Section "General Commissioning Requirements," checklists shall include, but not be limited to, the following:

1. Calibration of sensors and sensor functions.
2. Testing conditions under which test was conducted, including (as applicable) ambient conditions, set points, overridable conditions, and status and operating conditions that impact the results of test.
3. Control sequences for electrical and emergency generator systems.
4. Strength of control signal for each set point at specified conditions.
5. Response to control signals at specified conditions.
6. Sequence of response(s) to control signals at specified conditions.
7. Electrical demand and power input at specified conditions.
8. Power quality and related measurements.
9. Expected performance of systems, subsystems, and equipment at each step of test.
10. Narrative description of observed performance of systems, subsystems, and equipment. Notation to indicate whether the observed performance at each step meets the expected results.
11. Interaction of auxiliary equipment.
12. Issues log.

1.6. SUBMITTALS

A. The following submittals are in addition to those specified in Division 01 Section "General Commissioning Requirements."

B. Testing Procedures: CxA shall submit detailed testing plan, procedures, and checklists for each series of tests. Submittals shall include samples of data reporting sheets that will be part of the reports.

C. Certificate of Readiness: CxA shall compile certificates of readiness from Contractor certifying that systems, subsystems, equipment, and associated controls are ready for testing.

D. Certificate of Completion of Installation, Prestart, and Startup: CxA shall certify that installation, prestart, and startup activities have been completed.

E. Test and Inspection Reports: CxA shall compile and submit test and inspection reports and certificates, and shall include them in systems manual and commissioning report.

F. Corrective Action Documents: CxA shall submit corrective action documents.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1. TESTING PREPARATION

A. Prerequisites for Testing:

1. Certify that electrical systems, subsystems and equipment have been completed, calibrated, and started; are operating according to the Contract Documents; and that Certificates of Readiness are signed and submitted.
2. Certify that electrical instrumentation and control systems have been completed and calibrated; are operating according to the Contract Documents; and that pretest set points have been recorded.
3. Test systems and intersystem performance after approval of test checklists for systems, subsystems, and equipment.
4. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shut down, normal auto position, manual position, unoccupied cycle, emergency power, and alarm conditions).
5. Verify each operating cycle after it has been running for a specified period and is operating in a steady-state condition.
6. Inspect and verify the position of each device and interlock identified on checklists. Sign off each item as acceptable, or failed. Repeat this test for each operating cycle that applies to system being tested.
7. Check safety cutouts, alarms, and interlocks with life-safety systems during each mode of operation.
8. Annotate checklist or data sheet when a deficiency is observed.
9. Verify proper responses of monitoring and control system controllers and sensors to include the following:

    a. For each controller or sensor, record the indicated monitoring and control system reading and the test instrument reading. If initial test indicates that the test reading is outside of the control range of the installed device, check calibration of the installed device and adjust as required. Retest malfunctioning devices and record results on checklist or data sheet.
    b. Report deficiencies and prepare an issues log entry.

3.2. TESTING

A. Test systems and intersystem performance after test checklists for systems, subsystems, and equipment have been approved.

B. Perform tests using design conditions whenever possible.

1. Simulate conditions by imposing an artificial load when it is not practical to test under design conditions and when written approval for simulated conditions is received from CxA. Before simulating conditions, calibrate testing instruments. Set and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

C. Scope of Electrical Contractor Testing:

1. Testing scope shall include entire electrical installation, from incoming service throughout distribution systems to each space. It shall include measuring voltages and currents to verify effectiveness of operational and control functions.
2. Test all operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. Detailed Testing Procedures: CxA, with Electrical Contractor shall prepare detailed testing plans, procedures, and checklists for electrical systems, subsystems and equipment.

E. Electrical System Testing: Electrical Contractor shall provide a testing plan to verify performance of systems identified in Part 1 of this section. Plan shall include the following:

1. Sequence of testing and testing procedures for each item of equipment and section of wiring to be tested, identified by identification marker. Markers shall be keyed to Drawings for each wiring section showing the physical location of each item of equipment and electrical wiring test section. Drawings shall be formatted to allow each item of equipment and section of wiring to be graphically located and identified when referred to in the system testing plan.
2. Tracking checklist for managing and ensuring that all wiring systems have been tested.

F. Deferred Testing:

1. If tests cannot be completed because of a deficiency outside the scope of the electrical system, the deficiency shall be documented and reported to Owner. Deficiencies shall be resolved and corrected by appropriate parties and test rescheduled.
2. If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented and additional tests scheduled.

G. Testing Reports:

1. Reports shall include measured data, data sheets, and a comprehensive summary describing the operation of systems at the time of testing.
2. Include data sheets for each electrical systems to verify proper operation of the electrical systems, the system it serves, the service it provides, and its location. Provide space for testing personnel to sign off on each data sheet.
3. Prepare a preliminary test report. Deficiencies will be evaluated by Architect to determine corrective action. Deficiencies shall be corrected and test repeated.

END OF SECTION 260800

SECTION 260919 – ENCLOSED CONTACTORS

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 enclosed contactors.

1.3. SUBMITTALS

A. Product Data: Include dimensions and data on features, components, and ratings for lighting control devices. Provide product data on each control device specified.

B. Schedule: Prepare, and submit a contactor and relay schedule. Include the following information in the schedule.

1. Contactor Identification
2. Operator Type (Mechanical or Electrical)
3. Contact Configuration and
4. Circuit Numbers Controlled
5. Enclosure
6. Control Circuit
7. Voltage
8. Location

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

D. Maintenance Data: For lighting control devices to include in maintenance manuals specified in Division 01. Include instructions on adjusting, repairing, cleaning and lubricating each control device specified.

E. Project Record Documents: Accurately record actual locations of each lighting control device, and indicate circuits controlled.

1.4. QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control devices from a single source with total responsibility for compatibility of lighting control system components specified in this Section.

B. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA-70, Article 100, for their indicated use and installation conditions by a testing agency acceptable to authorities having jurisdiction.

C. Comply with NFPA 70, National Electrical Code.

D. Comply with NEMA ICS 2, Industrial Control Devices, Controllers and Assemblies.

E. Comply with ANSI/NEMA ICS 6, Enclosures for Industrial Controls and Systems.

1.5. COORDINATION

A. Coordinate features of devices specified in this Section with systems and components specified in other Sections to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions.

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. Contactors:

a. Automatic Switch Co.
b. Challenger Electrical Equipment Corp.
c. Cutler-Hammer Products; Eaton Corporation.
d. Furnas Electric Co.
e. GE Lighting Controls.
f. Hubbell Lighting, Inc.
g. Siemens Energy & Automation, Inc.
h. Square D Company; Power Management Organization.
i. Zenith Controls, Inc.

2.2. ENCLOSED CONTACTORS

A. Description: Electrically operated and electrically held, and complying with UL 508 and NEMA ICS 2.

1. Current Rating for Switching: UL listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballasts with 15 percent or less total harmonic distortion of normal load current).
Control Coil Voltage: Match control power source.
Provide fused control power transformer for each contactor as required by power source.

B. Basis of Design: Provide Square D Company Type “L” multi-pole contactors, or approved equal by acceptable manufacturer, in NEMA 1 Enclosure.

PART 3 - EXECUTION

3.1. INSTALLATION

A. Install equipment level and plumb and according to manufacturer's written instructions.

B. Mount lighting control devices according to manufacturer's written instructions and requirements in Division 26 Section "Common Work Results for Electrical".

C. Mounting heights indicated are to bottom of unit for suspended devices and to center of unit for wall-mounting devices.

D. All products and devices shall be installed in accessible locations.

E. Locate electrically held contactors where the eventual vibration and noise they will make will not be objectionable to building occupants.

F. Provide enclosures for each individual component.

3.2. CONTROL WIRING INSTALLATION

A. Install wiring between sensing and control devices according to manufacturer's written instructions and as specified in Division 26 Section 260519, "Low-Voltage Electrical Power Conductors and Cables".

B. Wiring Method: Install all wiring in raceway as specified in Division 26 Section 260533, "Raceway and Boxes for Electrical Systems", unless otherwise accessible ceiling space and gypsum board partitions.

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

D. Ground equipment.

E. Connections: 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.

F. Connect control devices to systems controlled, to achieve proper system operation.

3.3. IDENTIFICATION

A. Provide equipment nameplate(s) to identify equipment designation, power supply circuit, and load(s) controlled for each lighting control device. Refer to the Contract Drawings for additional information.

B. Identify power and control wiring according to Division 26 Section 260553, "Identification for Electrical Systems".

3.4. FIELD QUALITY CONTROL

A. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.

B. Inspect control components for defects and physical damage, testing, laboratory labeling, and nameplate compliance with the Contract Documents.

C. Check tightness of electrical connections with torque wrench calibrated within previous six months. Use manufacturer's recommended torque values.

D. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:

1. Continuity tests of circuits.
2. Operational Tests: Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions. Include testing of devices under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

E. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

F. Test Labeling: After satisfactory completion of tests and inspections, affix a label to tested components indicating test results, date, and responsible agency and representative.

G. Reports: Provide written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and retests.

3.5. CLEANING

A. Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

3.6. DEMONSTRATION

A. Train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on troubleshooting, servicing, adjusting, and preventive maintenance. Provide a minimum of two hours' training.
2. Training Aid: Use the approved final version of maintenance manuals as a training aid.
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 260919

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 lighting system.

D. Related Sections:

1. Division 26 Section 260500, “Common Work Results for Electrical”: Submittal requirements, general materials, installation requirements, and Record Document requirements.
2. Division 26 Section 262726, “Wiring Devices”: Toggle switches, receptacles.
3. Division 26 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 block diagram, and differentiate between manufacturer-installed and field-installed wiri

E. Samples:

1. Samples showing available color and finish selections for controls shall be submit the Architect.
2. Provide one sample of each field-connected device to the Division 26 Contractor 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 process 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.

Record Documents

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.

. 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 co[illegible] system
2. Quality System: Registered to ISO 9001:2000 Quality Standard, inclu[illegible] in-h[illegible] engineering for product design activities.
3. Furnish electrical control equipment for complete installation an[illegible] single source responsibility of lighting control.
4. Qualified to supply specified products and to honor claims against p[illegible]uct presented in accordance with warranty.
5. Manufacturing of all sensors shall occur in the USA. Ma[illegible]cturin[illegible] facility must be ROHS compliant.

B. Lighting Control System Components:

1. All applicable products must be UL / CUL [illegible]ted o[illegible]her acceptable national testing organization.
2. Listed by UL specifically for the [illegible]quire[illegible]ds. [illegible]ovide evidence of compliance upon request.
3. Listed and labeled as defined in N[illegible]70, A[illegible]cle 100, by a testing agency acceptable to Authorities Having Jurisdiction, and [illegible] for intended use.
4. All sensors and relat[illegible]elays shall [illegible] compatible with the specific lighting types controlled.
5. All sensors shall [illegible] of the [illegible]me manufacturer, mixing brands of sensors is not acceptable
6. All sensors and c[illegible]ol modules connected to more than 50 VAC shall be listed by Underwriter[illegible] Labora[illegible]es.
7. All sens[illegible]s and [illegible]ted e[illegible]ipment shall be manufactured in the United States of America.
8. All se[illegible]ors and re[illegible]ed equipment shall have a five-year warranty.

C. Installer [illegible]ualific[illegible]ns:

1. Ins[illegible]lers shall be factory-trained by the network lighting control system manufacturer.

1.8. DE[illegible]VERY, STORAGE, AND HANDLING

A. [illegible]Store products in manufacturer's unopened packaging until ready for installation.

Include installation, programming, and maintenance instructions.

[illegible]ROJECT 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 ten (10) years from date of purchase with factory startup.

1. Enhanced ten (10) year limited parts warranty, including:

a. Years 1-5:
i. 100 percent replacement parts coverage for manufacturer lighting control system components.
ii. 100 percent manufacturer labor coverage to troubleshoot/diagnose and repair lighting control issues on site (including but not limited to repair/replacement of occupancy/vacancy sensors, daylight sensors, power packs, wall switches, etc.), including travel/lodging expenses.
iii. First-available on-site or remote response time
b. Years 5-10: 100 percent replacement parts coverage for manufacturer lighting control system components.
c. 24 hours per day, 7 days per week, telephone technical support, excluding manufacturer holidays.

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 Supply Modules: Quantity equal to one unit for every 50 modules installed, but no fewer than one of each type.
Control Stations: 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. Hubbell Lighting Controls
5. Leviton Manufacturing Co., Inc.
6. WattStopper

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 zone.

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. All power packs shall have two (2) RJ-45 ports.

D. 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.

E. 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 the on condition. This system shall provide full 20 Amp switching of all load types, and be rated for 400,000 cycles.

F. Power packs shall be single circuit, or two circuits. When two circuit power packs the power packs must be wired directly to circuit breaker. Otherwise, power packs may be wired to the line or load side of the local switch.

G. Power packs for plug-load control shall be rated for switching 20-amperes.

H. Power packs for emergency lighting control shall be UL 924 listed.

I. All applicable products must be UL / CUL Listed or other acceptable national testing organization.

J. Slave modules shall be available for switching additional circuits. Slave module has same construction and specification as control module except without power supply function.

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. All sensors shall have two (2) RJ-45 Ports.

I. Sensors shall turn lights on only upon infrared detection.

J. Sensors shall indicate detected motion via a red LED.

K. Sensor controls shall be behind cover to resist tampering.

L. 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.

M. Sensors with dimming can control 0-10 VDC dimmable ballasts by sinking up to 20 mA of Class 2 current.

N. 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 0-10 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 an "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 once to accommodate physical changes in the space.

E. Dual zone operation 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.

H. All sensors shall have two (2) RJ-45 jacks.

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 have two (2) RJ-45 ports.

D. All switches shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.

E. Switch buttons shall be factory labeled as detailed on the Contract Drawings.

F. 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.

G. Devices shall have two to four buttons for selecting programmable lighting control profiles or acting as on/off switches.

H. Devices shall be capable of selecting a lighting profile by the system's upstream processor so as to implement selected lighting profile across multiple zones.

I. Switch finishes shall be as selected by Architect.

J. Refer to details and the "Network Wall Switches Schedule" of the Contract Drawings for specific requirements.

2.9. TOUCH SCREEN WALL SWITCHES

A. Devices shall have a 3.5" full color touch screen for selecting up to sixteen (16) programmable lighting control presets or activating up to sixteen (16) on/off/dim control switches.

B. Devices shall enable configuration of lighting presets, switched and dimmers via password protected screen setups.

C. Devices shall have full alpha-numeric nomenclature for scenes and lighting channels.

D. Devices shall enable user supplied .jpg screen saver image to be uploaded.

E. Devices shall have two (2) RJ-45 ports.

F. Switch finishes shall be as selected by Architect.

G. Refer to details and the "Network Wall Switches Schedule" of the Contract Drawings for specific requirements.

2.10. RELAY AND DIMMING PANELS

A. Panels shall incorporate up to forty-eight (48) field-configurable latching relays at 120/277 VAC or twenty-four (24) dual phase 208/480 VAC relays. Relays shall be rated to switch up to 30A ballast loads at 277 VAC.

B. All relays shall be individually programmable, and shall have local manual override lever.

C. Panels shall have one (1) 0-10 VDC dimming output for each relay.

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.

F. Panels shall have hinged keylock covers and field-installed voltage barrier(s) for normal/emergency use, or mixed voltage use.

G. Panels shall be UL924 listed for switching emergency circuits.

2.11. AUXILIARY INPUT / OUTPUT DEVICES

A. Devices shall be plenum rated and be inline wired, screw mountable, [or] an extended chase nipple for mounting to a ½" knockout.

B. Devices shall have two (2) RJ-45 ports.

C. Communication and low voltage power shall be delivered to each device via standard Cat5 low voltage cabling with RJ-45 connectors.

D. Devices shall have a dimming control output that can control 0-10V DC dimmable ballasts or LED drivers by sinking up to 20 mA of current.

E. Devices shall have an input that read a 0-10VDC signal from an external device.

F. Device shall have a switch input that can interface with either a maintained or momentary switch and run a switch event, or run a scene/remote control profile.

G. A specific I/O device shall sense signal of low voltage outdoor photocells.

2.12. 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.

2.13. 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.

2.14. MANAGEMENT SOFTWARE

A. Every device parameter shall be available and configurable remotely from the softwa

B. The following status monitoring information shall be made available from the ftwa or 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 be made available via the software:

1. Model Number
2. Model Descripti
3. Serial Number
4. Manufactu Date
5. Custom abel
6. Parent etwork D ce

D. Softwar hall pr de at ast three permission levels for users.

PART 3 - EXECUTION

3.1. X INATION

A. mine substrate areas and conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Lighting Management System.

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. In order for the system to be fully commissioned and operating to specification, database will need to be created. It is critical that the manufacturer receive information on load and control functionality so that the database can be written and fully tested by the manufacturer.

F. Define each dimmer's/relay's load type, assign each load to a zone and set control functions.

G. In order for the exterior daylight sensor to respond to daylight during the entire daylight period, the sensor should face north so that in the morning it will see daylight from the east and in the evening it will see daylight from the west. Directing the sensor due north also minimizes direct lighting exposure to the sensor which could overload the sensor.

H. Interior sensor work mainly with diffused light, as such they have a much higher lighting gain than exterior sensors. Electric light sources can affect these sensors unless the sensors are shielded from the light given off by electric light sources.

I. 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.

J. Label all wiring, raceways and enclosures in accordance with Division 26 Section "Electrical Identification".

K. Systems Integration:

1. Equipment Integration Meeting Visit

Facility Representative to coordinate meeting between Facility Representative, Lighting Control System Manufacturer and other related equipment manufacturers to discuss equipment and integration procedures.

L. 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.

M. 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.

N. 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.

O. 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.

P. 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 terminal 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.

D. Provide factory-marked buttons for wall stations as indicated on the Contract Drawings.

3.4. SERVICE AND SUPPORT

A. A Digital-Network Lighting Control System requires multiple site visits for proper startup. The first site visit ensures that the contractor is trained to install the system correctly. The second visit starts up the system and ensures that the system is operating per specification. The third visit trains the owner/end user on system operation and functionality.

B. 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 Echelon 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 low voltage circuits.
   ii. Verify connection and location of control devices.
   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 parameter 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.)

C. Training of customer representatives for Lighting Management Software

D. 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, control, 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 of 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

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. Provide video recordings of on-site system training sessions in accordance with Division 26 Section 260500, “Common Work Results for Electrical”.

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 additional 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 260943

SECTION 261120 - UTILITY INCOMING SERVICE PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the General Requirements, apply to the work specified in this Section.

B. Division 26 Section "Common Work Results for Electrical" sections apply to work of this section.

1.2 DESCRIPTION OF WORK

A. The Contractor shall provide all materials and labor required by the utility for service provisions.

B. The Contractor shall provide all materials and labor for complete primary conduit power, telephone and CATV distribution systems as shown on the drawings and as specified herein.

1.3 RELATED WORK

A. Division 26 Section 260500, "Common Work Results for Electrical".

B. Division 26 Section 260526, "Grounding and Bonding for Electrical Systems".

C. Division 26 Section 260533, "Raceway and Boxes for Electrical Systems".

D. Division 26 Section 260543, "Underground Ducts and Raceways for Electrical Systems".

1.4 UTILITY COMPANY COORDINATION

A. Contact *Digs Utility* (1-800-257-7777) prior to any excavation or underground work. The Contractor shall verify the location and depth of all utilities. Provide test pits to verify location and depth of all existing utilities crossing new incoming services.

B. Contact serving utility companies immediately upon award of Contract. Do not install related equipment until fully coordinated with appropriate utilities.

C. Provide all Construction Schedules, dates of requested services, outage windows, equipment locations, etc., necessary for utility work.

D. The Contractor shall ascertain, from the utility companies, the exact amount of work required in connection of the utilities. Work required which is not provided by the utility companies shall be provided by the Contractor.

E. Provide and coordinate all temporary services with utility companies.

F. The Contractor shall coordinate the required separation distances for all utilities.

G. The Contractor shall obtain all permits and permissions required.

1.5 SUBMITTALS

A. Certificate of Compliance: Contractor shall submit a document certifying that work complies with utility company requirements including the following:

1. Construction Standards of each Utility Company.
2. Trench and cover Depth.
3. Spacing and Support of Utilities.
4. Installation of underground marking tape.
5. Pull cords and Mandrels.

B. Submit Certificate of Compliance (and photographs if required) to each utility company for verification and approval.

C. Include Certificate of Compliance, and utility company approvals in O&M Manual.

D. The Contractor shall provide and submit all required documentation to each utility company, including service application, site plan and coordination drawings.

1.6 QUALITY ASSURANCE

A. Comply with the requirements of Delaware Electric Cooperative.

B. Comply with the requirements of NFPA 70, National Electrical Code.

C. Comply with the NECA Standard of Installation.

D. Comply with NFPA 70E, National Electrical Safety Code.

E. Contractor shall have experience with not less than 5 comparable projects for which the Contractor completed service provisions with each utility. Contractor shall be familiar with all current utility requirements and guidelines.

F. Obtain utility company inspector's approval for all work.

PART 2 - PRODUCTS

2.1 ELECTRIC UTILITY COMPANY PROVISIONS

A. The electric utility company is the City of Dover Electric Department**.** The point of contact is Aren Wright (awright@dover.de.us, 302-763-7070)

B. Coordinate service entrance equipment and layout with power company prior to ordering or installing any service entrance equipment.

C. Furnish and install all incoming raceway.

D. Coordinate cable, conduit, lug sizes, etc., for proper interface between utility-owned/installed equipment and Contractor-installed equipment.

E. Provide pad for utility company's transformer as required by the Utility. If utility company furnishes pre-cast transformer pad, schedule pick up/delivery with utility company.

F. Provide grounding and clearances as required by the Utility.

G. Contractor shall furnish and install all incoming raceway and service entrance cable. If the power company plans to install cable and/or conduit, the Contractor is responsible for proper coordination of cable, conduit, lug sizes, etc., for proper interface between utility-owned/installed equipment and Contractor-installed equipment.

H. The Contractor shall ascertain from the utility companies, the available short circuit fault current.

I. Equipment for Utility Company's Electric Metering:

1. Current-Transformer Cabinets: Comply with requirements of electrical power utility company.
2. Meter Sockets: Comply with requirements of electrical power utility company.
3. Housing: NEMA 250, Type 3R enclosure.

J. All mainline disconnects, tap boxes, C/T cabinets, meter sockets, and other service equipment shall be approved by the utility company prior to ordering.

2.2 TELEPHONE COMPANY PROVISIONS

A. Telephone Service Wall Space: Provide a wall-mounted ¾-inch fire-retardant painted plywood backboard, 8 feet high x 4 feet wide, as shown at location indicated on the drawings.

B. Provide adjacent to backboard two duplex convenience NEMA 5-20R receptacles connected to the power system. Provide (2) 12 AWG and (1) 12 AWG grounding conductor in ¾-inch conduit from receptacle to nearest 120 volt power panel.

C. Provide adjacent to the backboard, one 4 AWG copper grounding conductor extended from the building service ground point.

D. Provide conduit sleeves where cable is extended through partitions, walls, or floor slabs. Fire seal all openings after cable is installed.

E. Incoming Telephone service:

1. Coordinate incoming telephone service requirements with area public telephone system utility. Provide two (2) 4-inch Schedule 40 PVC underground conduits with pull cords from the telephone service equipment backboard to the vicinity of the power company's pad-mounted transformers unless otherwise indicated on the Drawings. Terminate conduits in the exact location and manner as directed by the telephone company.
2. Provide pre-cast pulling handholes in duct run in location(s) as directed if deemed necessary by the telephone utility. Size of handholes (L x W x H) shall be as required by the utility. Handholes installed in roadways shall be H20 roadway type.
3. Extend two (2) 4-inch PVC Schedule 40 underground service conduits along with primary electrical feeder from power company transformer location to 5'-0-inches beyond property line, or as indicated on the Drawings, then capped and stubbed.

4. In addition to the above requirements, install raceways in maximum lengths as required by telephone company and a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

F. Coordinate incoming raceway with telephone utility company. Provide required conduit size as determined by the telephone company.

G. Contractor shall be responsible for contacting and coordinating with the telephone company prior to ordering or installing any telephone entrance equipment and provisions.

2.3 CABLE TELEVISION COMPANY PROVISIONS

A. Incoming CATV Service:

1. Coordinate incoming CATV service requirements with the cable television company. Provide one (1) 4-inch Schedule 40 PVC conduit underground from the CATV service equipment backboard to the CATV pedestal in the vicinity of the power company's pad-mounted transformers unless otherwise indicated on the Drawings.
2. Extend one (1) 4-inch Schedule 40 underground service conduit to 5'-0" beyond the property line, then cap and stub. Terminate conduits in the exact location and manner as directed by the CATV company.
3. Extend one 4 -inch empty conduit from main CATV demarcation equipment to MDF Room and terminate at the CATV head-end equipment in exact location and manner as required.

2.4 TYPICAL INCOMING SERVICE PROVISIONS

A. Pull Cords: ¼-inch nylon pull cord with 500 lb. minimum tensile strength in each conduit.

B. Conduit, Elbows and Couplings: UL Schedule 40, EB-35, DB-60, DB-120, or ANSI/ASTM F-512 as required by utility for the specific application.

C. Spacers: Every 4 feet of conduit.

D. Splice Boxes: Purchase from utility company. Provide as required.

E. Utility Holes: Purchase from utility company. Provide as required.

F. Underground Marking: Provide detectable warning tape over all conduits.

G. Bends: Minimum 5 foot radius (horizontal) and 36-inch radius (vertical).

H. Concrete for encasement: As specified in Division 26 Section, "Underground Ductbanks", unless otherwise noted on the Drawings, with air entrainment and pea gravel.

I. Backfill: Virgin soil/select backfill only. Backfill shall be stone dust, rock-free earth, or top soil with no stones larger than 1-1/2-inches in diameter permitted.

J. Miscellaneous Materials: Provide bushings, bell ends, conduit plugs and other miscellaneous materials as required by utility companies.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mandrel: Contractor shall pull a mandrel (1/2-inch smaller in diameter than the conduit, and [illegible] inches long) through each conduit.

B. Pull Cords: Pull cords shall be left in all conduits, after mandrel pull.

C. Coordination: Coordinate location of telephone and CATV wall spaces, race[illegible]s, an[illegible]oxes, as necessary, to interface installation of telephone and CATV systems with other wor[illegible]

D. Bushings: Provide conduit bushing at each end of all conduits.

E. Bell Ends & Plugs: Provide bell ends and plugs for each conduit.

F. Sealing Conduits: Provide duct sealant in each conduit a[illegible]r utility ca[illegible]e is installed.

3.2 UTILITY COMPANY ELECTRIC-METERING EQUIPMENT

A. Install equipment according to utility com[illegible]ny's w[illegible]quirements. Provide grounding and empty conduits as required by utility company. P[illegible]lugs a[illegible]required by utility.

3.3 PREPARATION

A. Contractor shall provide co[illegible]uits[illegible]et or road crossings for all utility facilities.

B. Provide a level ar[illegible]at [illegible]grad[illegible]r all transformer, pedestal, and utility equipment locations.

C. Coordinate util[illegible]line sepa[illegible]ion requirements between electric, water, sewer, gas, telephone and CATV.

D. Con[illegible]tor sh[illegible]n clear area for all utility cables of rubble, debris, stumps, and other obstructions.

END OF SE[illegible]TION 261120

SECTION 261200 – MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SUMMARY

A. This Section includes the following:

1. Liquid-filled pad-mounted distribution transformers.

1.3. SUBMITTALS

A. Shop Drawings

1. Submit product data under provisions of General Conditions of the Contract and Section "Common Work Results for Electrical".
2. Include outline and mounting point dimensions of enclosures and accessories, unit weight, voltage, kVa, and impedance ratings and characteristics, loss data, efficiency at 25, 50, 75 and 100 percent rated load level, tap configurations, insulation system type, and rated temperature rise.
3. Include dimensioned drawings of any changes to existing installations to suit proposed equipment to be furnished.
4. Include manufacturer's installation instructions.
5. Submit 1/4-inch scaled shop drawings indicating transformer(s), equipment pads, clearance dimensions, existing conditions, and other major components. Shop drawings shall be specific to location being installed.

B. Factory Certified Tests

1. Factory certified tests shall be performed on the transformer being supplied and the results presented to the Project Manager for approval before shipment. The following factory certified tests shall be performed:

a. Insulation resistance tests shall be performed winding-to-winding and winding-to ground.
b. A turns ratio test shall be performed between windings at all service tap settings.
c. Overpotential test shall be made on all high and low voltage windings to ground.
d. Winding resistance tests shall be made for each winding at the in-service tap.
e. Verify that the tap settings/changer is at the desired ratio.
f. Measure secondary voltage phase-to-phase and phase-to-ground after final energization and prior to loading.
g. Verify and/or connect transformer "XO" to ground, load side of "WYE" systems.

1.4. OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of General Conditions of the Contract and Division 01.

B. Include procedures for cleaning unit, maintaining fluid levels, and replacing components.

1.5. QUALITY ASSURANCE

A. Manufacturer: Company specializing in distribution transformers with ten year[illegible] experience.

B. Comply with the latest requirements of IEEE, ANSI, ASTM, NEMA, a[illegible] NEMA Standards.

1.6. DELIVERY, STORAGE, AND HANDLING

A. Store and protect equipment in a warm, dry location wi[illegible] uniform t[illegible]perature. Cover ventilating openings to keep out dust.

B. Handle transformers using only lifting eyes and brack[illegible] provi[illegible] for that purpose. Protect units against entrance of rain, sleet, or snow if han[illegible] incle[illegible]t weather.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

A. Acceptable Manufacturers: [illegible]ject to compliance with requirements, supply equipment from one of the following m[illegible]rers. No other manufacturers are acceptable.
1. Oil-Fil[illegible] Trans[illegible]ers

a. [illegible]Square D [illegible]ompany
b. [illegible]Electric
c. Cooper Power
d. ABB, Inc.

2.2. O[illegible]FILLED TRANSFORMERS

A. [illegible]urnish and install at the locations indicated on drawings completely metal enclosed, c[illegible]partmented, oil-filled, pad-mounted distribution transformers.

B. Equipment shall have the following ratings:

1.	Capacity-		KVA rating as indicated on the Drawings @ 65 degrees C Rise.
2.	Primary Voltage	-	As indicated on the Drawings.
3.	Secondary Voltage:	-	As indicated on the Drawings.
4.	Taps:	-	Two (2) @ 2-1/2 percent Above and Below Nominal.
5.	Phase:	-	Three.
6.	Frequency:	-	60 Hertz.
7.	B.I.L.	-	95 kV.
8.	Insulation	-	O.I.S.C.
9.	Impedance	-	As indicated on the Drawings.

C. The unit shall be constructed for outdoor, fenceless, weatherproof service, and shall be suitable for mounting directly on the concrete foundation pad with high and low voltage cable entrance from below.

D. Interrupting capacity shall be a minimum of 42,000 amperes symmetrical. Provide low volta barrier.

E. The transformer shall be of sealed tank construction and furnished with the following feature

1. Combination drain and sampler valve (minimum 1-inch).
2. Upper filter press connection.
3. Liquid level gauge.
4. Dial thermometer.
5. Manual tap changer handle.
6. Pressure relief valve.
7. Lifting lugs.
8. Grounding pads.
9. Jacking lugs.
10. Tamper-proof handhole on tank.
11. Diagrammatic nameplate.
12. Provisions for padlocking and recessed bolting the hing ors of the air terminal chamber with access to the high voltage sectio y afte ening the low voltage section door.
13. Non-PCB Certification label.
14. The front of both compartments ll be mo ble to allow the transformer to be rolled or skidded into position over cond ubs. NSI tank grounding provisions shall be furnished in both compartments.
15. Filling plug-mounted in the cover.
16. Tap changer handle
17. Vacuum/Pressur auge.
18. Liquid Temperatu Ga e.
19. Winding Temperatu auge with alarm contacts and control relays.
20. *WARNI - H VO AGE* Label.

F. The unit shall construct of welded steel plate with no exposed boltheads, protrusions, sharp edges, o penin which would permit entrance by other than authorized personnel. The entire assem y shall be cl ed of weld scale, primed, and given a finish coat of "Forest Green", oil-resis e o oor enamel paint, or other color as selected by the Owner.

G. The trans mer shall be manufactured and tested in accordance with the latest applicable requirements of IEEE, NEMA and ANSI.

H. Liquid: Oil or less flammable liquid may be used depending on where installed and how the vault constructed. All oil shall be non-PCB. A permanent label shall be affixed to the tank indicating transformer dielectric fluids contained less than 50 PPM of PCB in accordance with EPA Requirements at the time of shipment.

HV dead front bushings shall be 600A, either universal wells or one-piece integrated for use with separable connectors. Bushings shall be externally clamped and front removable.

J. The low voltage bushings ($\leq$600V) shall be molded polymer, and provided with blade-type spade terminals with NEMA standard hole spacing arranged for vertical take-off. The low voltage neutral shall be an insulated bushing, grounded to the tank by a removable ground strap.

K. Provide a load break, gang operated, liquid immersed switch rated at 600A that is externally operable from the high voltage compartment through the use of a distribution hot-stick. Switch to

be 4-position "sectionalizing" type for use on an extended radial or loop-feed system with feed-from-the-left, feed-from-the-right, isolated-from-either-side, or through-feed to both sides.

L. Primary Overcurrent Protection: Two fuse system consisting of Bayonet-type, oil-immersed expulsion fuse in series with current-limiting backup fuse mounted inside the transformer under oil. The current limiting fuse should be located as near as practical to the incoming primary bushing, on the source side of the expulsion fuse. The two fuses shall be coordinated so that the expulsion fuse clears low energy faults on the secondary system and the current limiting fuse clears only high energy, includes overload protection, can be provided as an alternate with approval from the Owner. All transformer fusing shall be coordinated with upstream phase overcurrent devices.

M. Copper windings.

N. Transformer Start-Up: The transformer will not be started until all tests are complete and turned over to the Owner and the Engineer (2 sets) for review and approval.

PART 3 - EXECUTION

3.1. EXAMINATION

A. Verify field measurements are as shown on drawings.

B. Verify that required utilities are available, in proper location and ready for use.

C. Beginning of installation means installer accepts conditions.

3.2. INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Set transformer plumb and level.

C. Mount primary surge arresters inside of transformers.

D. Provide warning labels per NEMA 260.

3.3. EQUIPMENT MOUNTING PADS

A. Provide concrete equipment mounting pads as required for setting medium voltage transformers. Concrete shall be 3000 psi, 28-day minimum or as specified in Division 03. Refer to detail on electrical drawings for electrical equipment pads.

3.4. FIELD QUALITY CONTROL

A. Oil-Filled Transformers: Field testing will be performed by independent testing agency provided by the Contractor. Perform testing as required by NETA and as follows:

1. Sample insulating liquid in accordance with ASTM D3613 and perform dissolved gas analysis (DGA) in accordance with ANSI / IEEE and ASTM.
2. Turns ratio tests on the rated voltage connection and on all tap connections.

3. Polarity and phase-relation tests on the rated voltage connection.
4. Power factor tests in accordance with manufacturer's instructions.
5. Dielectric absorption test, winding-winding, and winding-ground.
6. Winding resistance for each winding at nominal tap position.

B. Any equipment which fails any of the required tests shall be replaced with new, or repaired at Owner's discretion. Equipment with marginal results, as interpreted by the Owner or Engineer, shall also be replaced or repaired at the Owner's discretion.

C. Check for damage and tight connections prior to energizing transformer.

3.5. ADJUSTING

A. Adjust transformer primary taps so that secondary voltage is within [ ] percent of rated voltage.

END OF SECTION 261200

SECTION 261301 – MEDIUM-VOLTAGE SWITCHGEAR

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. REFERENCE

A. All work under this Section shall be subject to Division 26 Section, "Common Work Results for Electrical" and any applicable conditions hereinbefore written for incidental work.

B. This section describes metal-enclosed switchgear assembly for application as Customer-Owned 15 kV equipment for installation on the customer's campus primary voltage loop.

1.3. CODES AND STANDARDS

A. The equipment furnished under this Section shall be in accordance with the latest applicable standards of ANSI, NEMA, IEEE, ICEA, OSHA, National Electrical Code and National Electric Safety Code.

B. Where any requirements specified or shown on the Contract Drawings exceed the listed standards, adhere to the higher standard. In case of conflict in requirements between two of more standards, decision of Engineer shall be final.

C. All equipment and materials furnished under this Section shall conform to all Federal, State, and Local laws or ordinances and if any requirements shown or specified conflicts with such requirements, laws or ordinances, provide such changes as are necessary to meet said requirements. The cost of such changes shall be included in the original bid. Where any standards shown on the Contract Drawings or specified herein exceed the minimum standards set by law, adhere to the higher standard.

D. Where applicable, all equipment and materials shall be listed and labeled by a nationally-recognized testing laboratory with equipment listing and follow-up service.

E. Switchgear shall be UL listed.

F. References

1. ANSI/IEEE C37.20.3 - Standard for Metal-Enclosed Interrupter Switchgear.
2. ANSI/IEEE C37.30 - Standard Definitions and Requirements for High-Voltage Air Switches, Insulators, and Bus Supports.
3. ANSI/IEEE C37.32 - Standard Schedules of Preferred Ratings, Manufacturing Specifications, and Application Guide for High-Voltage Air Switches, Bus Supports, and Switch Accessories.
4. ANSI/IEEE C37.34 - Test Code for High Voltage Air Switches.
5. ANSI/IEEE C37.35 - Guide for the Application, Installation, Operation, and Maintenance of High-Voltage Air Disconnecting and Load Interrupter Switches.

6. ANSI Standard - Green Finishes for Apparatus and Equipment.
7. Local Electrical Codes.
8. NFPA 70 - National Electrical Code, latest edition.

1.4. SUBMITTALS

A. Provide third party certified test abstracts for all air interrupter switchgear proposed for use on this project prior to shop drawing submittal and not later than twenty-one days after award of contract. The certified test abstracts shall contain, as a minimum, the manufacturers current engineering sales brochure showing all equipment proposed with model numbers (if available), and a summary of test procedures (described below) and resultant values actually recorded during the tests. The test procedure and resultant values summary shall contain model numbers (if available) similar to those listed in the current engineering sales brochure.

B. The following tests shall be performed on assemblies similar to those proposed for this project. Assemblies shall be complete with enclosure and all internal components such as switch, fuses (if required), ground pads, ground rods, metal and insulating barriers, etc.

1. Short-time current testing, to include rated momentary and rated three second tests as defined in ANSI/IEEE C237.30.4.6 and C37.20.3.5.2.
2. Rated continuous current and temperature rise tests as defined in ANSI/IEEE C37.32.3.2, C37.20.3.5.2, and C37.30.4.5.
3. Dielectric testing to include impulse withstand and 60 Hz tests as defined in ANSI/IEEE C37.32.3.2.
4. Load current interrupting testing as defined in ANSI/IEEE C37.30.4.7.
5. Fault closing tests within the enclosure: 3 phase testing on the switch and 1 phase testing on the fuses as defined in ANSI/IEEE C37.30.4.14.
6. Finish testing as defined in ANSI/IEEE C37.20.3.5.2.8. Samples must be prepared by the equipment manufacturer, not by the coating vendor, using production painting equipment with production paint applied on production substrates identical to that used of this project's equipment.

C. Submit the following shop drawings under the provisions of Division 01of the Contract and of this Division.

1. Outline dimensions, enclosure construction, shipping splits, lifting and supporting points.
2. Conduit and cable entrance locations.
3. Electrical single line diagram.
4. Equipment electrical ratings.
5. Certification of ratings of the integrated metal-enclosed switchgear assembly consist of the basic switch and fuse components in combination with the enclosure.
Product data for components and accessories.
7. Manufacturer's installation instructions.
8. Fuse curves for proposed fuses.

1.5. OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of General Conditions.

B. Include parts list, fuse replacement, equipment adjustment, and lubrication instructions.

1.6. QUALITY ASSURANCE

A. Enclosure Manufacturer: Company specializing in medium voltage interrupter switch enclosures with thirty years documented experience.

B. Switch Manufacturer: Company specializing in medium voltage interrupter switch compone with five years documented experience.

C. Fuse Manufacturer; Company specializing in medium voltage fuses and fuse compo with years documented experience.

D. The manufacturer/assembler of the overall switchgear assembly shall be comp ly a solely responsible for the performance of the basic switch as well as the compl grate ssembly as rated.

1.7. DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site and protect from damage.

B. Store and protect products.

C. Accept switchgear on site and inspect of d age.

1.8. EXTRA MATERIALS

A. Provide maintenance materi s und provisions of Section "General Electrical Requirements" and Division 01, Section "*Clo out Pr es*".

B. Provide one (1) 15 stic signed for pulling fuses.

C. Provide one se f spare fus for each set installed. Place these spare fuses in the metal pocket in the front d or c ach fused witch assembly.

1.9. COMPLIANC STANDARDS AND CODES

A. The pad-m ted gear shall conform to or exceed the applicable requirements of the following standards and codes:

1. All portions of ANSI C57.12.28, covering enclosure integrity for pad-mounted equipment.
2. Article 490.21(e) in the National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.
3. All portions of ANSI, IEEE, and NEMA standards applicable to the basic switch and fuse components.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:

1. S & C Electrical (Basis of Design).
2. Square D; Schneider Electric.
3. ABB Control, Inc.

2.2. ENCLOSURE DESIGN

A. To ensure a completely coordinated design, the pad mounted gear shall be constructed in accordance with the minimum construction specifications of the fuse and switch manufacturer to provide adequate electrical clearances and adequate space for fuse handling.

B. In establishing the requirements for the enclosure design, consideration shall be given to all relevant factors such as controlled access, tamper resistance, and corrosion resistance.

2.3. RATINGS

A. Ratings: The ratings for the integrated pad-mounted gear shall be as scheduled on the Contract Drawings.

B. The momentary and two-time duty-cycle fault-closing ratings of switches, momentary rating of bus, interrupting ratings of fuses, and one-time duty-cycle fault-closing capabilities of fuses with integral load interrupters shall equal or exceed the short-circuit ratings of the pad-mounted gear.

C. The manufacturer of the pad-mounted gear shall be completely and solely responsible for the performance of the basic switch and fuse components as well as the complete integrated assembly as rated.

D. The manufacturer shall furnish, upon request, certification of ratings of the basic switch and fuse components and/or the integrated pad-mounted gear assembly consisting of the switch and fuse components in combination with the enclosure.

2.4. INSULATION

The interrupter-switch and fuse-mounting insulators shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:

B. Operating experience of at least 15 years under similar conditions.

C. Adequate leakage distance established by test per IEC Publication 507, First Edition, 1975.

D. Adequate strength for short-circuit stress established by test.

E. Conformance with applicable ANSI standards.

F. Homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum

resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulators during installation or maintenance of the pad-mounted gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.

2.5. HIGH VOLTAGE BUS

A. Bus and interconnections shall consist of aluminum bar of 56% IACS conductivity.

B. Bus and interconnections shall withstand the stresses associated with short circuit currents up through the maximum rating of the pad mounted gear.

C. Bolted aluminum-to-aluminum connections shall be made with a suitable number of 1/2"-13 galvanized steel bolts and with two Belleville spring washers, one under the bolt head and one under the nut. Bolts shall be tightened to manufacturer's specifications.

D. Before installation of the bus, all electrical contact surfaces shall first be prepared by machine abrading to remove any aluminum-oxide film. Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant.

2.6. GROUND-CONNECTION PADS

A. A ground-connection pad shall be provided in each compartment of the pad-mounted gear.

B. The ground-connection pad shall be constructed of 3/16" thick steel, which shall be nickel plated and welded to the enclosure and shall have a short circuit rating equal to that of the pad-mounted gear.

C. Ground-connection pads shall be coated with a uniform coating of an oxide inhibitor and sealant prior to shipment.

2.7. ENCLOSURE

A. The pad-mounted gear enclosure shall be of unitized monocoque (not structural-frame-and-bolted-sheet) construction to maximize strength, minimize weight, and inhibit corrosion.

B. The basic material shall be 11-gauge hot-rolled, pickled and oiled steel sheet.

All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth. The gas-metal-arc welding process shall be employed to eliminate alkaline residues and to minimize distortion and spatter.

D. To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware.

E. The base shall consist of continuous 90 degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.

F. The door openings shall have 90 degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry.

G. Polyurethane self-adhesive bumpers shall be placed on the left-hand door channel to prevent the right-hand door from abrading the paint, and on the center door divider to prevent the left-hand door from rubbing against the center door divider.

H. Enclosure top side edges shall overlap with roof side edges to create a mechanical maze which sh[illegible] allow ventilation to help keep the enclosure interior dry while discouraging tampering or insert[illegible] of foreign objects.

I. A heavy coat of insulating "no-drip" compound shall be applied to the inside surfac[illegible] of the roo[illegible] minimize condensation of moisture thereon.

J. Insulating interphase and end barriers of NEMA GPO3 grade fiberglass reinforc[illegible] polyes[illegible] shall be provided for each interrupter switch and each set of fuses where requi[illegible] achie[illegible] BIL ratings. Additional insulating barriers of the same material shall separate the [illegible]ont com[illegible]tme[illegible]s from the rear compartments and isolate the tie bus (where furnished).

K. Full length steel barriers shall separate side-by-side compart[illegible]

L. Interrupter switches shall be provided with dual purpos[illegible]ront barr[illegible]s. These barriers, in their normal hanging positions, shall guard against inad[illegible]ent c[illegible]act w[illegible] live parts. It shall also be possible to lift the barriers out and insert them into th[illegible]pen g[illegible]hen the switch is open. These barriers shall meet the requirements of Sectio[illegible]G of t[illegible]National Electrical Safety Code (ANSI Standard C2).

M. Interrupter switches shall be provided with [illegible]ow p[illegible]els to allow viewing of the switch position without removing the dual-purpose front barri[illegible]. Window panels shall be removable to facilitate phasing and shall be secured to [illegible]nclosure wit[illegible]stainless-steel or zinc-nickel-plated hardware.

N. Each fuse shall be provide[illegible]with a d[illegible]l-purpose front barrier. These barriers, in their normal hanging positions, shall guard agains[illegible]ertent contact with live parts. It shall also be possible to lift these barriers out and inser[illegible]m in[illegible]e open gaps when the fuses are in the disconnect position. These barriers shall me[illegible]he re[illegible]eme[illegible]of Section 381G of the National Electrical Safety Code (ANSI Standard C2).

O. The enc[illegible]ure sh[illegible]e pr[illegible]ded with an instruction manual holder.

P. Lifti[illegible]abs[illegible]all be removable. Sockets for the lifting tab bolts shall be blind tapped. A resilient materia[illegible]ll be placed between the lifting tabs and the enclosure to help prevent corrosion by protecting [illegible]finish against scratching by the tabs. To further preclude corrosion, this material shall be closed cell to prevent moisture from being absorbed and held between the tabs and the enclosure in the event that lifting tabs are not removed.

Q. [illegible]ase spacer shall be provided to increase the elevation of live parts in the pad-mounted gear above the mounting. Base spacer height shall be as scheduled on the Contract Drawings.

[illegible]OORS

A. Doors shall be constructed of the same material as the switchgear enclosure. Refer to paragraph “Enclosures” of this Section, for additional information.

B. Door-edge flanges shall overlap with door-opening flanges and shall be formed to create a mechanical maze that shall guard against water entry and discourage tampering or insertion of foreign objects, but shall allow ventilation to help keep the enclosure interior dry.

C. Doors shall have a minimum of two extruded-aluminum hinges with stainless-steel hinge pins, and interlocking extruded-aluminum hinge supports for the full length of the door to provide strength, security, and corrosion resistance. Mounting hardware shall be stainless steel or zinc-nickel-plated steel, and shall not be externally accessible to guard against tampering.

D. In consideration of controlled access and tamper resistance, each door (or set of double doors) shall be equipped with an automatic three-point latching mechanism.

1. The latching mechanism shall be spring loaded, and shall latch automatically when door is closed. All latch points shall latch at the same time to preclude partial latching.
2. A pentahead socket wrench or tool shall be required to actuate the mechanism to unlatch the door and, in the same motion, recharge the spring for the next closing operation.
3. The latching mechanism shall have provisions for padlocking the door and incorporate a means to protect the padlock shackle from tampering and that shall be coordinated with the latches such that:

    a. It shall not be possible to unlatch the mechanism until the padlock is removed, and
    b. It shall not be possible to insert the padlock until the mechanism is completely latched closed.

4. Doors providing access to solid-material power fuses shall have provisions to store spare fuse units or refill units.
5. Each door shall be provided with a zinc-nickel-plated steel door holder located above the door opening. The holder shall be hidden from view when the door is closed, and it shall not be possible for the holder to swing inside the enclosure.

2.9. FINISH

A. Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly into the unitized structures.

B. All exterior seams shall be welded and sanded smooth for neat appearance.

C. To remove oil and dirt, to form a chemically and anodically neutral conversion coating to improve the finish-to-metal bond, and to retard underfilm propagation of corrosion, all surfaces shall undergo a thorough pretreatment process comprised of a fully automated system of cleaning, rinsing, phosphatizing, sealing, drying, and cooling before any protective coatings are applied. By utilizing an automated pretreatment process, the enclosure shall receive a highly consistent thorough treatment, eliminating fluctuations in reaction time, reaction temperature, and chemical concentrations.

After pretreatment, protective coatings shall be applied that shall help resist corrosion and protect the steel enclosure. To establish the capability to resist corrosion and protect the enclosure, representative test specimens coated by the enclosure manufacturer's finishing system shall satisfactorily pass the following tests:

1. 4000 hours of exposure to salt-spray testing per ASTM B 117 with:

    a. Underfilm corrosion not to extend more than 1/32" from the scribe as evaluated per ASTM D 1645, Procedure A, Method 2 (scraping); and
    b. Loss of adhesion from bare metal not to extend more than 1/8" from the scribe.

2. 1000 hours of humidity testing per ASTM D 4585 using the Cleveland Condensing Type

Humidity Cabinet with no blistering as evaluated per ASTM D 714.

3. 500 hours of accelerated weathering testing per ASTM G 53 using lamp UVB 313 with no chalking as evaluated per ASTM D 659, and no more than 10% reduc¬tion of gloss as evaluated per ASTM D 523.
4. Crosshatch adhesion testing per ASTM D 3359 Method B with no loss of finish.
5. 160-inch-pound impact adhesion testing per ASTM D 2794 with no chipping or cracki
6. Oil resistance testing consisting of a 72-hour immersion bath in mineral oil with n hift color, no streaking, no blistering, and no loss of hardness.
7. 3000 cycles of abrasion testing per ASTM 4060 with no penetration to the strate.
8. Certified test abstracts substantiating the above capabilities shall be furnishe pon r

E. After the finishing system has been properly applied and cured, welds along the losur ottom flange shall be coated with a wax-based anticorrosion moisture barrier the reas added corrosion resistance.

F. A resilient closed-cell material, such as PVC gasket, shall be applied e enti underside of the enclosure bottom flange to protect the finish on this surface ratch during handling and installation. This material shall isolate the bottom flange fr the alk ity o a concrete foundation to help protect against corrosive attack.

G. After the enclosure is completely assembled and the mpon (switches, fuses, bus, etc.) are installed, the finish shall be inspected for scuf d scra es. Blemishes shall be touched up by hand to restore the protective integrity of th inis

H. The finish shall be olive green, Munsell 7G 9/1.5

2.10. CORROSION RESISTANCE

A. To guard against corrosion ll ardware (including door fittings, fasteners, etc.), all operating-mechanism parts, a ther p subject to abrasive action from mechanical motion shall be of either nonferrous aterial r ga nized or zinc-nickel-plated ferrous materials. Cadmium-plated ferrous parts sh not be us

2.11. INTERRUPTER SWITCHES

A. Interrup witches shall have a two-time duty-cycle fault-closing rating equal to or exceeding the short-circu ting of the pad-mounted gear. These ratings define the ability to close the interrupter switch twice against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum voltage with current applied for at least cycles. Certified test abstracts establishing such ratings shall be furnished upon request.

Interrupter switches shall be operated by means of an externally accessible 3/4" hex switch-operating hub. The switch-operating hub shall be located within a recessed stainless-steel pocket mounted on the side of the pad-mounted gear enclosure and shall accommodate a 3/4" deep-socket wrench or a 3/4" shallow-socket wrench with extension. The switch-operating-hub pocket shall include a padlockable stainless-steel access cover that shall incorporate a hood to protect the padlock shackle from tampering. Stops shall be provided on the switch-operating hub to prevent overtravel and thereby guard against damage to the interrupter switch quick-make quick-break mechanism. Labels to indicate switch position shall be provided in the switch-operating¬-hub pocket.

C. Each interrupter switch shall be provided with a folding switch-operating handle. The switch-operating handle shall be secured to the inside of the switch-operating-hub pocket by a brass chain.

The folded handle shall be stored behind the closed switch-operating-hub access cover.

D. Interrupter switches shall utilize a quick-make quick-break mechanism installed by the switch manufacturer. The quick-make quick-break mechanism shall be integrally mounted on the switch frame, and shall swiftly and positively open and close the interrupter switch independent of the switch-operating-hub speed.

E. Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path which parallels the open gap of the interrupter switch to positively isolate the load circuit when the interrupter switch is in the open position.

F. Interrupter switch contacts shall be backed up by stainless-steel springs to provide constant high contact pressure.

G. Interrupter switches shall be provided with a single blade per phase for circuit closing including fault closing, continuous current carrying, and circuit interrupting. Spring-loaded auxiliary blades shall not be permitted. Interrupter switch blade supports shall be permanently molded in place in a unified insulated shaft constructed of the same cycloaliphatic epoxy resin as the insulators.

H. Circuit interruption shall be accomplished by use of an interrupter which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place completely within the interrupter, with no external arc or flame. Any exhaust shall be vented in a controlled manner through a deionizing vent.

I. Interrupter switches shall have a readily visible open gap when in the open position to allow positive verification of switch position.

J. Ground studs shall be provided at all switch terminals. Ground studs shall also be provided on the ground pad in each interrupter switch compartment and on the terminals and ground pad in any bus compartment. The momentary rating of the ground studs shall equal or exceed the short-circuit ratings of the pad-mounted gear.

K. Key interlocks shall be provided to guard against opening fuse¬-compartment door(s) unless all switches in series with it (only, where furnished) are locked open.

L. Base-mounted distribution-class surge arresters, metal-oxide type, shall be provided at all source switch terminals.

2.12. FUSES

A. Solid-Material Power Fuses

1. Fuses shall be disconnect style, solid-material power fuses, and shall utilize refill-unit-and-holder or fuse-unit-and-end-fitting construction. The refill unit or fuse unit shall be readily replaceable and low in cost.
2. Fusible elements shall be non-aging and non-damageable so that it is unnecessary to replace unblown companion fuses on suspicion of damage following a fuse operation.
3. Fusible elements for refill units or fuse units rated 10 amperes or larger shall be helically coiled to avoid mechanical damage due to stresses from current surges.
4. Fusible elements, that carry continuous current, shall be supported in air to help prevent damage from current surges.
5. Each refill unit or fuse unit shall have a single fusible element to eliminate the possibility of unequal current sharing in parallel current paths.

6. Solid-material power fuses shall have melting time-current characteristics that are permanently accurate to within a maximum total tolerance of 10% in terms of current. Time-current characteristics shall be available which permit coordination with protective relays, automatic circuit reclosers, and other fuses.
7. Solid-material power fuses shall be capable of detecting and interrupting all faults whether large, medium, or small (down to minimum melting current), under all realistic conditions of circuitry, with line-to-line or line-to¬-ground voltage across the fuse, and shall be capable of handling the full range of transient recovery voltage severity associated with these faults.
8. All arcing accompanying operation of solid-material power fuses shall be confined to the fuse, and all arc products and gases evolved shall be effectively contained within the exhaust control device during fuse operation.
9. Solid-material power fuses shall be equipped with a blown-fuse indicator that shall provide visible evidence of fuse operation while installed in the fuse mounting.
10. Final fuse type and size, for each switch, shall be coordinated with electric utility next upstream overcurrent protective device. Final fuse selections shall be approved by electric utility.

B. Fuse-mounting jaw contacts shall incorporate an integral load interrupter that shall permit live switching of fuses with a hook-stick.

1. The integral load interrupter housing shall be of thermoplastic material.
2. The integral load interrupter shall keep the current path continuously. Auxiliary blades or linkages shall not be used.
3. Live switching shall be accomplished by a firm, steady opening pull on the fuse pull ring with a hook-stick. No separate load-interrupting tool shall be required.
4. The integral load interrupter shall require a hard pull to unlatch the fuse to reduce the possibility of an inadvertent opening operation.
5. Internal moving contacts of the integral load interrupter shall be self-resetting after each opening operation to permit any subsequent closing operation to be performed immediately.
6. Circuit interruption shall take place completely within the integral load interrupter with no external arc or flame.
7. The integral load interrupter and the fuse shall be provided with separate fault-closing contacts and current-carrying contacts. The fuse hinge shall be self-guiding and, together with the fault-closing contacts, shall guide the fuse into the current-carrying contacts during closing operations. Circuit-closing inrush currents and fault currents shall be picked up by the fault-closing contacts, not by the current-carrying contacts or interrupting contacts.
8. Integral load interrupters for fuses shall have a one-time duty-cycle fault-closing capability equal to the interrupting rating of the fuse, and a two-time duty-cycle fault-closing capability of 13,000 amperes rms asymmetrical at 14.4 kv or 25 kv. The duty-cycle fault-closing capability defines the level of available fault current into which the fuse can be closed the specified number of times (once or twice), without a quick¬-make mechanism and when operated vigorously through its full travel without hesitation at any point, with the integral load interrupter remaining operable and able to carry and interrupt currents up to the emergency peak-load capabilities of the fuse.

C. Fuse terminal pads shall be provided with a two-position adapter, making it possible to accommodate a variety of cable-terminating devices.

D. Ground studs shall be provided at all fuse terminals. One ground stud shall also be provided on the ground pad in each fuse compartment. The momentary rating of the ground studs shall equal or exceed the short-circuit ratings of the pad-mounted gear.

E. A fuse-storage compartment shall be provided in three source interrupter-switch compartment(s). Each fuse-storage compartment shall provide space for storing three spare fuse holders or fuse units

with end fittings for solid-material power fuses.

2.13. LABELING

A. Hazard-Alerting Signs

1. All external doors shall be provided with "Warning—Keep Out—Hazardous Voltage Inside—Can Shock, Burn, or Cause Death" signs.
2. The inside of each door shall be provided with a "Danger—Hazardous Voltage—Failure to Follow These Instructions Will Likely Cause Shock, Burns, or Death" sign. The text shall further indicate that operating personnel must know and obey the employer's work rules, know the hazards involved, and use proper protective equipment and tools to work on this equipment.
3. Interrupter switch compartments shall be provided with "Danger" signs indicating that "Switches May Be Energized by Backfeed."
4. Fuse compartments shall be provided with "Danger" signs indicating that "Fuses May Be Energized by Backfeed."
5. Barriers used to prevent access to energized live parts shall be provided with "Danger—Keep Away—Hazardous Voltage—Will Shock, Burn, or Cause Death" signs.

B. Nameplates, Ratings Labels, and Connection Diagrams

1. The outside of each door (or set of double doors) shall be provided with a nameplate indicating the manufacturer's name, catalog number, model number, date of manufacture, and serial number.
2. The inside of each door (or set of double doors) shall be provided with a ratings label indicating the following: voltage ratings; main bus continuous rating; short-circuit ratings (amperes rms symmetrical and Mva three-phase symmetrical at rated nominal voltage); the type of fuse and fuse ratings including duty-cycle fault-closing capability; and interrupter switch ratings including duty-cycle fault-closing and short-time (momentary, amperes rms asymmetrical and one-second, amperes rms symmetrical).
3. A three-line connection diagram showing interrupter switches, fuses with integral load interrupter, and bus along with the manufacturer's model number shall be provided on the inside of each door (or set of double doors), and on the inside of each switch-operating-hub access cover.

2.14. ACCESSORIES

End fittings or holders, and fuse units, refill units for original installation, as well as one spare fuse unit, refill unit, or interrupting module for each fuse mounting shall be furnished.

A fuse handling tool as recommended by the fuse manufacturer shall be furnished.

C. A total of three (3) sets of grounding jumpers, each three (3) feet in length, shall be provided complete with a storage bag for each set.

D. A voltage tester with audiovisual signal capability and batteries, shotgun clamp–stick adapter, and storage case shall be provided.

E. A shotgun clamp stick, ten (10) feet in length, shall be provided complete with a canvas storage bag.

F. Locks:

1. Provide padlocks on all gear when installed. Padlocks shall match Owner's present padlocks and be keyed per Owner's requirements.
2. Provide Owner with two keys for each padlock. All pad locks shall be keyed alike.
3. All units shall be furnished with enough padlocks to completely lock each units.

G. All cable termination points shall be supplied with a bronze body, tin plated, two bolt, connector suitable for up to 750 KCMIL stranded copper or aluminum.

PART 3 - EXECUTION

3.1. MISCELLANEOUS INSTALLATION REQUIREMENTS:

A. All noncurrent carrying metal parts of the equipment shall be connected to the ground system. The switchgear ground bus shall be connected at a minimum of two places to the ground system with 4/0 AWG bare copper wire.

B. Exothermic joints shall be used for all connections below grade. Double-bolted compression type connectors shall be used for above-grade ground connections to equipment ground bus.

3.2. INSPECTION AND TEST REQUIREMENTS

A. A Certificate of Electrical Inspection covering all new main substations and reconnection of a modified or relocated existing main substation shall be obtained from the proper Code enforcing authority and a copy forwarded to the Owner and the local utility company before such equipment may be energized.

B. Visually inspect switchgear for evidence of damage and verify that surfaces are ready to receive work.

C. Visually inspect to confirm all items and accessories are in accordance with Specifications and drawings.

D. Verify field measurements and clearances as shown on the Drawings.

E. Verify that required utilities are available, in proper location, and ready for use.

F. Beginning of installation means installer accepts existing surface conditions.

G. Visually inspect for physical damage.

Perform mechanical operator tests in accordance with manufacturer's instructions. Check blade alignment and arc interrupter operations.

. Check torque of all bolted connections, including cable terminations.

J. Tough up paint all chips and scratches with switchgear manufacturer-supplied paint and leave remaining paint (one pint minimum) with Owner.

END OF SECTION 261301

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SUMMARY

A. This Section includes 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 260500, "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.

1.6. 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. 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. 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).
4. Siemens Energy & Automation, Inc.
5. Acme Electric Corp.; Transformer Division.
6. Hammond Power Systems

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 9001:2015.

D. Ratings Information

1. All insulation 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.
3. 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.
4. 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 500kV – 60dB; to 700kVA – 62dB; 701 to 1000kVA – 64dB; 1001 to 1500kVA – 65dB; 15 to 200 – 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
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 ISO9001:2015.

D. Ratings Information

1. All insulating materials are to exceed NEMA ST20 standards and be rated for 220 degrees 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-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 degrees C average temperature rise.
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, load 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 to 1MHZ – 40dB
   b. Transformer Mode: 0 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. 0 to 50kVA – 45dB; 51 to 150kVA – 50dB; 151 to 300kVA – 55dB; 301 to 500kVA – 60dB; 501 to 700kVA – 62dB; 701 to1000kVA – 64dB.

2.5. SEALED UNIT SUBSTATIONS

A. Description: Compact power supply with epoxy-resin encapsulated low voltage transformer, factory-installed primary main and secondary main circuit breakers, and panelboard section with bolt-on circuit breakers.

B. Standards:

1. Unit substations 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 UL1062.

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 180 degrees C UL component recognized insulation system.
2. Transformers shall be 115 degrees C temperature rise above 40 degrees C ambient.
3. Transformers shall have a minimum of 2 – 5% full capacity primary taps. Exact voltages and taps to be as designated on the plans or the transformer schedule.
4. The maximum temperature of the top of the enclosure shall not exceed 50 degrees C rise above a 40 degrees C ambient.
5. Sound levels shall be warranted by the manufacturer not to exceed the NEMA ST1-20 Average Sound Levels Decibels by kVA.

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.
3. Core and coil shall be embedded in sand-cast resin mixture encapsulating the core and coil completely.
4. 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.
5. Primary and secondary terminals shall be clearly marked and shall be able to accommodate wire sized for 125% of nameplate current.
6. The transformer enclosures shall be ventilated 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. Basis of Design: Square D Company, Mini Power-Zone Unit Substations

2.6. BUCK-BOOST TRANSFORMERS

A. Description: Insulating autotransformers with a single winding with two end terminals, and one or more terminals at intermediate tap points, which are used to slightly adjust an application's voltage up or down.

B. Ratings / Electrical Characteristics:

1. Contractor shall select primary and secondary voltages and VA rating based on application and load being served. The following options shall be available at a minimum:

a. 120V x 240V primary with a 12/24V or 16/32V secondary
b. 240V x 480V primary with a 24/48V secondary
c. 50VA to 3kVA

2. Temperature Rise:

a. 50VA through 150VA - 55°C
b. 250VA through 500VA - 80°C
c. 750VA through 3kVA - 115°C

C. Transformers shall be designed, manufactured and tested in accordance with the following standards:

1. UL 506 - "Specialty Transformers"
2. ANSI Z535.3 - "American National Standard for Criteria for Safety Symbols"
3. NEMA ST20 - "Dry Type Transformers for General Applications"

D. Enclosure: Transformers shall be equipped with a wall-mounted NEMA 3R rated enclosure designed and constructed for indoor or outdoor use.

E. Basis of Design: Square D Company, Class 7414

2.7. 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 each 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 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, anchorage, 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 manufacturer recommended 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.

C. Occupancy Adjustments: When requested within twelve (12) months of Substantial Completion, provide on-site assistance in readjusting transformer tap settings to suit actual occupied conditions. Provide up to two (2) visits to the project site for this purpose at no additional cost. Make voltage recordings at equipment/outlets selected by Owner, and record transformer secondary voltages for up to 48 hours.

END OF SECTION 262200

SECTION 262413 - 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 service and distribution switchboards rated 600 volts and less.

B. Provide design and engineering, labor, material, equipment, related services and supervision required, including, but not limited to, manufacturing, fabrication, inspection, and installation for switchboards as required for the complete performance of the work and as shown on the Drawings and as specified herein.

C. Switchboards shall be fully rated for the AIC identified in the switchboard schedules on the Contract Drawings.

D. Related Sections include the following:

1. Division 26 Section 260500, "Common Work Results for Electrical" for general and installation materials and methods.
2. Division 26 Section 260553, "Identification for Electrical Systems" for identification materials for labeling switchboards, including, but not limited to equipment nameplates.
3. Division 26 Section 260573, "Overcurrent Protective Device Coordination Study" for engineering analysis involving switchboards specified herein.
4. Division 26 Section 264113, "Lightning Protection for Structures" for requirements for lightning protection systems specific to surge protective devices in switchboards as specified herein.

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. 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, “Deadfront Distribution Switchboards.”
3. NEMA PB 2.1, “General Instructions for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.”
4. NEMA PB 2.2, “Application Guide for Ground Fault Protective Devices.”

I. National Fire Protection Association (NFPA):

a. NFPA 70, “National Electrical Code.”
b. NFPA 70B, “Electrical Equipment Maintenance.”
c. 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.”
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 switchboard, overcurrent protective device, surge protective device, ground fault protector, 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 system, clearly differentiating between manufacturer-installed and field-installed wiring. Show 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 certified by testing agency.

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. Switchboard Circuit Directories: For installation of switchboards. Submit final versions after load balancing.
4. Project Record Data: Record actual locations of switchboards, indicating actual feeder circuit arrangement.

1.6. 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 10 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.

1.7. 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 lo 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 ilated a protected from weather, moisture, soiling, extreme temperatures, and humidity.

D. Store so condensation will not occur on or in switchboards. Provide temporary h rs as quired to avoid condensation.

E. Handle switchboards according to NEMA PB 2.1. Use only factory talled lift g provisions.

1.8. PROJECT CONDITIONS

A. Environmental Requirements: Do not install switchb ds u pac s enclosed and weatherproof, wet work space is completely and nominally dry, rhead ork is complete, and ambient temperature and humidity conditions are and e con ously maintained at values near those indicated for final occupancy.

B. Verify Dimensions: Verify NEC and all Cod arranc equirements by field measurements. Locate switchboard to meet installation tolerances.

C. Determine suitable path for ving witchboard into place considering Project conditions.

D. Revise locations and elevat m those indicated as required to suit Project conditions.

1.9. WARRANTY

A. Genera arranty warranty specified in this Article shall not deprive Owner of other rights Own may h e under other provisions of the Contract Documents and shall be in addition to, and run c ur nt with, other warranties made by Contractor under requirements of the Contract Docume

B. 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. XTRA MATERIALS

A. Keys: Provide two (2) spares for each type of switchboard lock, including key interlock(s).

B. Touchup Paint: Provide one (1) standard size canister of manufacturer's touch-up paint for each switchboard, 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. Acceptable 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 Corporation; & Cutler-Hammer Products.
3. General Electric (GE).
4. Siemens Energy & Automation Inc.

2.2. MANUFACTURED UNITS

A. Front-Accessible Switchboard: Front and rear aligned, with [illegible]s for [illegible].

1. Main Device: Fixed, individually-mounted.
2. Branch Devices: Fixed, panel-mounted plug-on devices rated 1200 amperes and less, individually-mounted devices rated more than 1200 amperes.

B. Ratings: Provide nominal system voltage, continuous main-bus 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 comply with environmental conditions at installed location as indicated below:

1. Dry, Interior Locations: NEMA 1

B. 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 fronts shall be 4-piece surface and shall have rounded corners and edges free of burrs.

C. Barriers: Adjacent switchboard sections shall be isolated by means of physical barriers. Barriers shall permit checking of bus bolt tightness.

D. Hinged Front Panels: All front covers shall be screw removable with a single tool and all doors shall be hinged with removable hinge pins.

E. Buses and Connections: Three phase, four wire, unless otherwise indicated.

1. Bus Composition: Silver-plated copper, hard-drawn, minimum of 98 percent conductivity. Plating shall be applied continuously to bus work. The switchboard bussing shall be of sufficient cross-sectional area to meet UL 891 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 2. Tapered buses shall not be acceptable.
2. Group-Mounted Feeder Vertical Bus Stack:
    a. Bus stack shall be capable of mounting feeder breakers with different frame sizes and number of poles across from one another on the bus stack.
    b. Non-conducting surface films shall be removed during circuit breaker installation by a wiping action of the circuit breaker jaws.
    c. The design of the circuit breaker jaws and bus stack shall dissipate heavy-on forces under fault conditions.
    d. Bolted lap joint connections for feeder breakers shall not be allowed for group-mounted feeders.
3. Ground Bus:
    a. 1/4-by-2-inch minimum size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder- and branch-circuit ground conductors.
    b. Provide ground lug and ground bus firmly secured to each vertical section structure and shall extend the entire length of the switchboard.
    c. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
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.

F. Future Devices: All unused spaces provided, unless otherwise indicated, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware. Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit breaker compartment.

G. Expansion Provisions: The switchboard shall be designed for future expansion, with full size horizontal bussing throughout and extension stub-outs.

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.
5. Ground Fault Protection: Integral to circuit breaker with adjustable pickup and time delay settings, push-to-test feature, and ground-fault indicator.
6. Shunt Trip: 120 volt trip coil energized from separate circuit, set to trip at 75percent of rated voltage.
7. 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.

2.5. INCOMING MAIN SECTION DEVICE

A. Main Circuit Breaker(s).

1. Electronic trip, molded case, 100% 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. Main circuit breakers rated 1000 amperes or more shall be equipped with integral ground-fault protection with the following adjustments:
   a. Ground Fault Pickup
   b. Ground Fault Delay
3. 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.
4. All adjustments shall have discrete settings (fully adjustable) and shall be independent of other adjustments.
5. Circuit breaker trip system shall be microprocessor-based true RMS sensing designed with sensing accuracy through the thirteenth (13th) harmonic.
6. Sensor ampere ratings shall be as indicated herein or on the Drawings.
7. Local visual trip indication for overload, short circuit and ground fault trip occurrences. Long time pickup indication shall signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker.
9. Provide phase loss/failure relay that will trip main circuit breaker on loss of any single phase. Relays that operate on loss of all three phases are not acceptable.
10. Basis of Design: Square D Company, Micrologic® Power Trip Units

2.6. 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. The interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulator laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
3. 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.
4. Line side circuit breaker connections are to be jaw type.
5. Furnish thermal magnetic molded case circuit breakers for 250A frames and below.
6. All unused spaces provided, unless otherwise specified, shall be fully equipped for devices, including all appropriate connectors and mounting hardware.

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. Circuit breakers where the highest continuous current trip setting can be adjusted to 1200A or higher, shall be equipped with an energy reducing maintenance setting, in compliance with National Electrical Code Article 240.87.
3. All adjustments shall be 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.

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.

2.7. DISTRIBUTION SECTION DEVICES – INDIVIDUALLY MOUNTED CIRCUIT BREAKERS GREATER THAN 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. The interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulator laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
3. 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.

4. Line side circuit breaker connections are to be jaw type.
5. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.

B. Electronic Trip Molded Case Circuit Breakers

1. Electronic trip, molded/insulated case, 80% rated circuit breaker(s) with microprocessor, 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 reduction 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 microprocessor 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.

2.8. SURGE PROTECTIVE DEVICES

A. Description: Surge Protective Devices (SPDs) installed in switchboards.

B. 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.

C. 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"

D. 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.

E. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not

be considered in lieu of demonstrated withstand testing of SPD, per NEC Article 285.6

F. 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.

G. 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."

H. Minimum surge current capability (single pulse rated) per phase shall be as follows:

1. Switchboards: 320kA

I. 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.

J. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

System Voltage	L-N	L-G	L-L	N-G
480Y/277V	1200V	1200V	1800V	1200V

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

System Voltage	MCOV	Allowable System Voltage Fluctuation (%)
480Y/277V	320V	15%

L. SPD shall be constructed of one self-contained suppression module per phase.

M. 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. The status of each SPD module shall be monitored on the front cover of the enclosure as well as on the module.

N. A push-to-test button shall be provided to test each phase indicator. Push-to-test button shall activate a self-test change of dry contacts for testing purposes.

O. 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.

P. 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.

Q. Terminals shall be provided for necessary power and ground connections.

R. 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.

S. 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.

2.9. ELECTRONIC METER WITH DIGITAL DISPLAY

A. Three-phase electronic type suitable for connection to three (3) and four (4) wire circuits with the following features:

1. Meter shall be capable of measuring amperes (A), volts (V), power factor (PF), kilowatts (kW), kilowatt demand (kWd), kilovolt-amperes (KVA), kilovolt-amperes demand (kVAd), kilowatt-hours (kWh), kilovolt-ampere hours (kVAh) and Total Harmonic Distortion (THD).
2. Meter shall be equipped with one (1) MOD-BUS serial port and two (2) ethernet ports. One (1) ethernet port shall be interfaced with building's ATC system, and one (1) ethernet port shall be interfaced with building LAN to provide data on demand to the Owner.
3. Meter shall provide a 0-10VDC, 4-20mA, or dry contact pulse output signal for interfacing with the building management (automatic temperature control) system provided under Division 23.
4. Meter shall be equipped with high-visibility, anti-glare, backlit LCD display offering multi-phase measurements, summary service bar charts, intuitive navigation and selectable languages.
5. Measurements shall meet the accuracy requirements of IEC 62053-22 Class 0.5S and ANSI C12.20 Class 0.5S.
6. Meter shall be equipped with non-volatile on-board memory for capable of extensive logging of min/max values, energy and demand, maintenance data, alarms and any measured parameter.
7. Meter shall provide custom alarming with time stamping.
8. Current transformers shall be Square D Type 100R or approved equal.
9. Potential transformers shall be provided where 277/480V metering is required, unless electronic meter is DIN mount compatible and is mounted directly to the switchboard bussing.

B. Electronic meters shall be Square D Company, PowerLogic PM 8000 Series, or approved equal by acceptable manufacturer.

2.10. INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, ANSI/IEEE C57.13.

B. Potential Transformers: Secondary voltage rating of 120 volts and NEMA accuracy class of 0.3 with burdens of W, X, and Y.

C. Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.

D. Current Transformers for Neutral and Ground Fault Current Sensing: Connect secondaries to ground overcurrent relays to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit breaker ground fault protection.

2.11. CONTROL POWER

A. Control Circuits: 120 volts, supplied through secondary disconnecting devices from control power

transformer.

B. Control Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

C. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control Wiring: Factory-installed, with bundling, lacing, and protection included. Provide flexible conductors for 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.12. IDENTIFICATION

A. Compartment Nameplates: Engraved laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws or suitable adhesive.

B. Nameplates: Engraved nameplates with 1/4" high white lettering shall be furnished for all mains and feeder circuits including control fuses and as required for all indicating lights and instruments. Nameplates shall give item designation and circuit number as well as frame size and appropriate trip rating. Furnish Master Nameplate giving switchboard designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number.

C. Switchboards used as service-entrance equipment shall be labeled as the same.

D. Refer to Division 26 Section 260553, "Identification for Electrical Systems" 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 switchboards.

1. Do not proceed with installation until unsatisfactory conditions have been corrected.
2. Verify dimensions of switchboard and working space clearances.

3.2. INSTALLATION

A. Install switchboards level and plumb as indicated, according to manufacturer's written instructions and NEMA PB 2.1.

B. Support switchboards on concrete housekeeping pads. Refer to Division 26 Section 260500, "Common Work Results for Electrical" for requirements for housekeeping pads.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount printed, basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of

finished wood or metal and cover instructions with clear acrylic plastic. Mount on the front of switchboards.

E. Install overcurrent protective devices, surge protective devices, and instrumentation.

F. Do not energize or connect service-entrance equipment and switchboards to their sources until su[ch] protective devices are properly installed and connected.

3.3. CONNECTIONS

A. Connect switchboards and components to wiring systems and to ground as indicat[ed] and in[st]ructed by manufacturer. Tighten electrical connectors and terminals, including [gr]ound b[us] according to manufacturer's published torque tightening values. Use a calib[rat]ed torq[ue] wrench. Where manufacturer's torque values are not indicated, use those specified in UL 486A a[nd] UL 486B.

B. Neutral and ground conductors shall be isolated and termin[ated] at [the] respective bus bars. There shall only be one neutral-ground connection in se[rvi]ce-entra[nce] equipment by means of a removable main bonding jumper. Neutral and ground c[on]nections at one bus bar shall not be acceptable.

C. Coordinate interface between digital electr[ic] meter and building LAN with Division 27 Contractor and Owner. Provide factory as[sis]tance with setting up e-mail notifications for alarms, data logging, etc.

3.4. IDENTIFICATION

A. Identify field-installed wi[rin]g and [com]ponents and provide warning signs as specified in Division 26 Section 260553, “Identi[fic]ation for Electrical Systems”.

B. Label each switchboard c[om]partment with nameplates as specified herein.

C. Contractor shall provide a [fra]med record drawing indicating final arrangement and modifications and ca[pac]ities of switchboard and electrical system one-line for easy reference. Mount on switchboard room wall. Contractor shall provide record drawing.

3.5. 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. This applies to main nameplate as well as nameplates for distribution section devices.
4. Verify that switchboard phase identification nameplates are installed.
5. Verify that switchboard arc flash hazard labels are installed.
6. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer’s instruction manual.
7. Check switchboard mounting, area clearances, and alignment and fit of components.
8. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer’s instructions for proper torque values.
9. Perform visual and mechanical inspection and related work for over-current protective

devices.

10. Verify that all neutral conductors are bonded to the system ground at the service-entrance prior to installation of the surge protective device.
11. Verify that neutral-ground bonds do not exist at locations that are not service entrances o separately derived power sources.
12. Verify that circuit breaker trip settings are adjusted as recommended in coordination stu provided under Division 26 Section "Engineering Systems Analysis".

B. Switchboard Electrical Testing: After installing switchboards and after electrical cir has b energized, demonstrate product capability and compliance with requirements

1. Testing Agency: Provide services of a qualified independent testing a cy to erform specified testing. Provide set of Contract Documents to test ation. Include full updating on final system configuration and parameters wh they s lemen or differ from those indicated in the original Contract Documents.
2. Inspect accessible components for cleanliness, mechanical elect al integrity, and damage or deterioration. Verify that temporary bra as been removed. Include internal inspection through access panels d cover
3. Inspect bolted connections for tightness acco g to ma acturer's published torque values or, if not available, those specified i UL 4 and U 486B.
4. Protective Device Ratings and Settings: ify in ed ratings and settings to be appropriate for final system configura nd pa eters. Where discrepancies are found, recommend final protective device ting and setti s. Use accepted ratings or settings to make the final system adjustme
5. Make continuity tests of each ci Refe to Division 26 Section "Conductors and Cables" for testing specific to feeder d ors.
6. Perform ground resistan test on syste and equipment ground connections
7. Test main and subfe ove current protective devices.
8. Test ground fault evices i accordance with NETA ATS 7.14.
9. Test phase loss re (s) s e-entrance equipment to verify that phase loss relays are fully operational.
10. NETA T ing.

    a. Perform e h visual and mechanical inspection and electrical test stated in NETA TS, S ions 7.1, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate for all devices ra 200-amperes and larger.
    b. Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest.
    c. 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.
11. Infrared Scanning: Perform an infrared scan of all electrical connections in each switchboard, 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.

12. Perform all other manufacturer specific tests as indicated in manufacturer's literature.
13. 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.

14. Submit all test reports to the Architect for review and approval.
15. Provide copy of all test reports in the O&M manual.

3.6. ADJUSTING

A. Set field-adjustable circuit breaker settings as indicated in coordination study provided under Division 26 Section 260573, "Overcurrent Protective Device Coordination Study".

3.7. CLEANING

A. Upon completion of installation, inspect interior and exterior of switchboard(s). 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 switchboard(s) shall be without damage at time of Substantial Completion.

3.9. DEMONSTRATION AND TRAINING

A. Provide a minimum of four (4) hours of training and demonstration of switchboard operations, settings, adjustment, and maintenance.

B. Topics to be covered include, but are not limited to, the following:

1. Extracting recorded data from electricity meter.
2. Operation of electricity meter.
3. Changing/Setting of e-mail address for alarms/notifications from electricity meter.
4. Operation of electronic trip circuit breakers.
5. Operation of arc energy reduction maintenance switches.

END OF SECTION 262413

SECTION 262416 - 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, manufacture, 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 260500 "Common Work Results for Electrical" for general materials and installation methods.
2. Division 26 Section 260553, "Identification for Electrical Systems" for labeling materials.
3. Division 26 Section 260573, "Overcurrent Protective Device Coordination Study" for engineering analysis involving panelboards specified herein, including but not limited to short-circuit analysis.
4. Division 26 Section 264113, "Lightning Protection for Structures" for requirements for lightning protection systems specific to surge protective devices in panelboards as specified herein.

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

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.

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 for panelboards to include in operation and maintenance manuals specified in Division 0
2. Warranty Data: Submit manufacturer's standard warranty docu
3. Panelboard Circuit Directories: For installation in panelboard Submi final versions after load balancing.
4. Project Record Data: Record actual locations of panelboar indicating actual branch circuit arrangement.

1.6. QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be 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 standar

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 Proj

C. Testing Agency Qualifications: In addition to the requirements specified in Division 01 Section Quality Control, 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.
Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory as defined in OSHA Regulation 1910.7.

ELIVERY, 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 panelboards 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 panelboard(s) into place considering Project conditions.

D. Revise locations and elevations from those indicated as required to suit Project conditions.

1.9. 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. 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. General Electric (GE).
4. Siemens Energy & Automation Inc.

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
2. Damp, Wet Exterior Locations: NEMA 3R
3. Corrosive Environments: NEMA 4X Stainless Steel

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 entire 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 be of 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 extension 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 circuit protective device ampere ratings indicated on the Drawings.

F. Directory Frame: Clear plastic cardholder, mounted inside each panelboard door.

Service Equipment Approval: Listed for use as service equipment for panelboards with main service disconnect.

Special Features: Include the following features for panelboards as indicated:
1. Provide 200 percent rated neutral bus for all computer and non-linear loads.
2. Subfeed: Over-current protective device or lug provision as indicated.
3. Feed-Through Lugs: Provide mechanical lugs to accommodate the quantity, size, and material of the conductors shown on the Contract Drawings.
4. 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.
3. Current-limiting 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.
    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, set to trip at 75 percent of rated voltage.

2.4. POWER DISTRIBUTION PANELBOARDS

Interior

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. Minimum short-circuit current ratings for distribution panelboards shall be verified by short circuit analysis specified under Division 26 Section 260573, “Overcurrent Protective Device Coordination Study” prior to ordering equipment.
4. 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.

5. 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.
6. Interior trim shall be of dead-front construction to shield user from all energized parts.
7. 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.
8. A solidly bonded equipment ground bar shall be provided.
9. 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 higher continuous current trip setting can be adjusted to 1200A or higher, shall be equipped with an energy reducing maintenance setting, in compliance with National Electrical Code Article 240.87.
3. All adjustments shall be 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 rating shall be as indicated herein or on the Drawings.
6. Local visual trip indication for overload, short circuit trip occurrences.
7. Long time pickup indication shall signal when loading approaches or exceeds the adjusted ampere setting of the circuit breaker.
8. 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 120[illegible] 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, [illegible] 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 [illegible] 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-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 brackets shall be provided for ease of interior installation.
c. Trim frame 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.
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.

[illegible]. 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 and 120/240V panelboards, and 18,000 AIC RMS symmetrical amperes for 277/480V panelboards.
2. Minimum short-circuit current ratings shall be verified by short circuit analysis specified under Division 26 Section “Electrical Systems Analysis” prior to ordering equipment.
3. 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.

4. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Article 230.
5. All current carrying parts shall be insulated from ground and phase to phase by high dielectric strength thermoplastic.
6. 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.
7. Interiors shall be field convertible for top or bottom incoming feed.
8. Main circuit breakers shall be vertically mounted.
9. Sub-feed circuit breakers shall be vertically mounted.
10. Interior leveling provisions shall be provided for flush mounted applications.
11. 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.

2. Type 3R/5/12 Enclosures

a. Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be finished with ANSI 49 gray [baked enamel electrodeposited] [polyester acrylic powder paint] over cleaned phosphatized steel.
b. Doors shall be gasketed and be equipped with a locking vault handle.
c. A clear plastic directory card holder shall be mounted on the inside of the door.
d. All lock assemblies shall be keyed alike, one (1) key shall be provided with each lock.

3. Type 4/4X Enclosures (Stainless Steel)

a. Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be finished with Type 316 stainless steel.
b. Doors shall be gasketed and be equipped with a locking vault handle.
c. A clear plastic directory card holder shall be mounted on the inside of the door.
d. 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. FUSIBLE PANELBOARDS FOR EMERGENCY SYSTEMS

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

B. Panelboard Rating

1. Panelboards shall be labeled with a short-circuit current rating (SCCR) equal to or greater than that indicated on the associated schedules or drawings.
2. Main service and service entrance rated panelboards shall be UL listed.
3. Panelboards shall be rated 600Vac and have a current rating as indicated on the associated schedules or drawings.
4. Panelboard overcurrent protective device interrupting ratings shall be UL listed and rated for the maximum available fault current.
5. Current ratings, configuration of poles and number of circuits shall be indicated on associated schedules or drawings. Mersen Fused Coordination Panelboard Specifications.

C. Construction

1. Panelboard branch circuits shall incorporate overcurrent protection using fuse types that are manufactured by at least three independent companies to assure replacement availability.
2. Interiors shall be factory assembled.
3. Bus bars shall be tin-plated copper with sufficient cross sectional area to meet UL 67 temperature rise requirements.
4. 200 ampere rated neutral shall be standard, 400 ampere rated neutral shall be provided

where indicated in the associated schedules or drawings.

5. Bonded neutral shall be provided where specified in associated drawings.
6. Isolated or non-isolated equipment ground bar shall be provided as indicated in the associated schedules or drawings.
7. Where a service-entrance rated panelboard is indicated in associated schedules or drawings, a bonded neutral and non-isolated equipment ground bar shall be provided by the manufacturer.
8. Main lug conductor terminations:

    a. MLO terminations shall be rated for 60/75°C, Cu-Al
    b. Main disconnect terminations shall be rated for 75°C, Cu Or

9. Where specified on drawings, NEMA 1 and NEMA 3R panelboards shall be for top or bottom incoming feed.
10. Where specified on drawings and specifications, the panelboards shall meet seismic zone ratings based upon third party testing.

D. Main Disconnect

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

E. Branch Circuit Overcurrent Protection

1. Both circuit breaker and fuse shall have visible circuit ON/OFF indication.
2. Fuse holder shall provide open fuse indication via permanently installed neon indicating light where included in the plans and specifications.
3. Overcurrent protective devices shall be UL Listed, with voltage and short-circuit current ratings meeting the available voltage and short current shown on the drawings. The combination circuit breaker and fuse shall have amperage ratings and number of poles as indicated on the panelboard schedule.
4. Circuit breakers and fuses shall be finger-safe components with trim installed.
5. Fuse holder shall be designed so as not to allow fuse removal while fuse terminals are energized.
6. No special tools shall be required for fuse removal.
7. Breakers and fuses shall be clearly marked with device amperage.
8. Circuit breakers and fuses shall be clearly marked with device amperage.
9. Branch overcurrent protective devices shall minimize the types and rating of fuses to only 30A, 60A and 100A for simple maintenance.
10. Branch circuit load terminations shall be UL listed for one and two wires per terminal.
11. Multipole branch circuit overcurrent protection devices shall trip on an overcurrent of any pole to prevent single-phasing of the load.
12. Branch circuit overcurrent protection devices shall be “Bolt In.’
13. Branch circuit overcurrent protection devices shall be resettable without replacing fuses for overcurrents for at least twice their rating.
14. Short circuits shall be cleared within ½ cycle to prevent sensitive equipment disruptions.

F. Main and Branch Overcurrent Protection

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

G. Enclosure

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

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

2.7. SURGE PROTECTIVE DEVICES

A. Description: Integrated Surge Protective Devices (SPD) in panelboards.

B. 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.

C. 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"

D. 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.

E. 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

F. 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.

G. 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."

H. Minimum surge current capability (single pulse rated) per phase shall be as follows:

1. Distribution Panelboards: 240kA
2. Branch Panelboards: 120kA

I. 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) for Delta and impedance grounded Wye systems.

J. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

System Voltage	L-N	L-G	L-L	[illegible]
208Y/120V	700V	700V	1200V	00V
480Y/277V	1200V	1200V	1800V	200V

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

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

L. SPD shall be constructed of one self-contained suppression module per phase.

M. 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.

N. The status of each Suppression Module shall be monitored on the front cover of the enclosure as well as on the module.

O. A push-to-test button shall be provided to test each phase indicator. Push-to-test button shall activate solid state circuitry contacts for testing purposes.

P. 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.

Q. 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.

R. Terminals shall be provided for necessary power and ground connections.

S. 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.

T. 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.

2.8. 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 260553, "Identification for Electrical Systems" for additional information.

PART 3 - EXECUTION

3.1. EXAMINATION

A. Examine elements and surfaces to receive panelboards 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. Provide Fusible Panelboards as specified in this section for all emergency panelboards.

C. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.

D. 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.

E. Provision for Future Circuits at Flush-Mounted Panelboards: Stub 1-inch (25 mm) empty conduits from panelboard to wire trough above panelboard as detailed on the Contract Drawings. Empty conduit quantities shall be 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

F. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.

G. Two or three pole circuit breakers shall be common trip type. Single pole breakers with handle ties will not be permitted.

H. Tandem circuit breakers will not be permitted.

I. Provide ground buses in panelboards as indicated on the Drawings. Ground bus shall be similar in all respects to neutral bus.

J. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289, Application Guide for Ground Fault Circuit Interrupters.

K. 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.

L. Branch circuit breakers serving electric water coolers shall be GFCI type for personnel protection (5mA).

M. Branch circuit breakers serving refrigerators/freezers and vending machines shall be GFCI type for personnel protection (5mA).

N. Branch circuit breakers serving receptacles and appliances located under kitchen ventilation hoods shall be equipped with shunt-trip mechanisms.

O. 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.

P. 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 260553, “Identification for Electrical Systems”.

B. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws. Refer to Division 26 Section 260553, "Identification for Electrical Systems" 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. Verify that panelboard arc flash hazard labels are installed.
6. Exercise and perform operational tests on all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
7. Check panelboard mounting, anchorage, clearances, and alignment and fit of components.
8. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
9. Perform visual and mechanical inspection and related work for over-current protective devices.
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. Test ground fault devices in accordance with NETA ATS 7.14.
9. NETA Testing:

    a. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers,

for all devices rated 100-amperes and larger.

b. Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest.

c. 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.

10. Infrared Scanning: Perform an infrared scan of all electrical connections in each panelboard, as follows:

a. Remove equipment covers so terminations are accessible to scanning.

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.

11. Test Labeling: On satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.

12. Submit all test reports to the Architect for review and approval.

13. Provide copy of all test reports in the O&M manual.

3.7. ADJUSTING

A. Set field-adjustable circuit-breaker trip ranges as indicated in coordination study provided under Division 26 Section 26057 "Overcurrent Protective Device Coordination Study".

3.8. 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.

3.9. 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 262416

SECTION 262716 – COMMERCIAL PEDESTALS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SCOPE

A. Section includes pad-mounted, weatherproof electrical enclosures with custom configurations of electrical equipment including but not limited to circuit breakers, transformers, load centers, photocells, etc.

B. Provide all labor, materials, equipment, and services necessary to provide commercial pedestals as indicated herein and on the Contract Drawings.

1.3. RELATED WORK

A. Division 03 Section, "Cast in Place Concrete".

B. Division 26 Section, "Underground Ducts and Raceways for Electrical Systems".

C. Division 26 Section, "Grounding and Bonding for Electrical Systems".

1.4. QUALITY ASSURANCE

A. Manufacturer Qualifications: Firm experienced in manufacturing utility structures of types and sizes required and similar to those indicated for this Project. Firm must have a minimum of a 3-year record of successful in-service performance.

B. Comply with NFPA 70: Electrical Code and ANSI C2 National Electrical Safety Code for components and installation.

C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms Listed and Labeled: As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications; A Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

D. Coordinate layout and installation of pedestals with final arrangement of other utilities as determined in the field.

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

1.5. SUBMITTALS

A. Submit shop drawings and product data under provisions of General Conditions of the Contract and Division 26.

B. Indicate material specifications, dimensions, capacities, size and location of openings, reinforc[illegible] details, and accessory locations.

C. Provide product data for utility holes, handholes, pedestals, and accessories.

D. Submit details on 8-1/2-inches x 11-inches sheets showing cross-section of eac[illegible]ll of [illegible]h utility hole, handhole with size of conduits and identify cabling at new structures.

E. Submit Site Shop Drawings indicating the proposed locations of all ha[illegible]holes. P[illegible]posed deviations from the Details and Drawings shall be clearly marked on the Shop [illegible]wings.

F. Submit manufacturer's installation instructions under pro[illegible]s of Ge[illegible] Conditions of the Contract.

G. Inspection report for factory inspections, according [illegible]ASTM [illegible]103[illegible]

H. Coordination drawings showing duct profiles [illegible]oordi[illegible]n with other utilities and underground structures. Include plans and sections draw[illegible] to ac[illegible] scal[illegible].

I. Qualification data for firms and persons spe[illegible]d in Q[illegible]lity Assurance Article to demonstrate their capabilities and experience. Include list of com[illegible] projects with project names, addresses, names of Architect and Owner, and ot[illegible]formation specified.

J. Field test reports indicati[illegible]and i[illegible]ting test results relative to compliance with performance requirements of Field Quali[illegible]Control Article in Part 3 of this Section.

K. Submit Shop Dr[illegible]ings, i[illegible]ding[illegible]e following:

1. Drawi[illegible] for eac[illegible] size and configuration of handhole and utility hole with details of [illegible]ccesso[illegible]ments.
2. Diag[illegible]ms showing dimensioned locations for openings for duct penetrations of handhole an[illegible]tility hole walls.
3. [illegible]awings depicting size, shape, configuration and identification of all cast cover plates and th[illegible] mounting rings.
4. Drawings for each commercial service pedestal configuration.

1.6. PROJEC[illegible]ECORD DOCUMENTS

A. Submit under provisions Division 26 Section 260500, “Common Work Results for Electrical”.

B. Accurately record actual locations of each pedestal.

1.7. DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Division 26 Section 260500, “Common Work Results for Electrical”.

B. Accept products on site. Inspect for damage.

C. Lift and support units only at designated lifting or supporting points.

1.8. COORDINATION

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

PART 2 - PRODUCTS

2.1. MANUFACTURERS

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

1. Commercial Pedestals:

a. Milbank Manufacturing (Basis of Design)
b. Myers Pedestals
c. Tesco Controls, Inc.
d. VIT Products

2.2. COMMERCIAL PEDESTALS

A. Description: Pad-mounted, weatherproof electrical enclosures for site power distribution.

B. Construction:

1. Exterior construction shall comply with UL50 requirements and shall be of G90 galvanized steel with Federal Specification 595 polyurethane industrial grade powder paint of 1.7 mil minimum thickness, unless otherwise indicated.
2. Interior construction shall be G90 galvanized steel and 1.7 mil minimum thickness polyurethane industrial grade powder coat painted. No fasteners except sealing screws shall be removable by external access. Hinges shall be stainless steel and of the continuous pin hinge type.

C. Mounting: The pedestal mounting bolts shall not be externally accessible. The pedestal shall be offered with an optional base designed to be embedded in concrete in place of anchor bolts. Either pedestal mounting base or anchor bolt kit is required for installation.

D. Features:

1. Compartment door to be hinged on the left-hand side.
2. A stainless steel pad-lockable hasp provided to secure compartment.
3. A door keeper provided to keep the door in an open position.
4. A print pocket on the inside of the door shall hold all wiring schematics, circuit directories and instructions in a clear, weatherproof sleeve.
5. Required UL labeling shall be located on the inside of the compartment door.
6. All stainless steel external hardware (screws, bolts, hinges, handles, hasps, and sealing screws).
7. Distribution and control equipment shall be behind an internal dead-front door with a

quarter-turn securing latch and be hinged to open more than 90 degrees.

8. The dead-front door shall be hinged on the same side as the compartment door.
9. All distribution and control equipment shall be factory wired using 600 volt wire sized to NEC and UL requirements.

E. Electrical: Pedestals shall contain molded-case circuit breakers, load centers, sealed transformers and/or lighting control devices as indicated on the Contract Drawings. See Contract Drawings for additional information.

1. Circuit breakers shall comply with requirements of Division 26 Section 262813 "Enclosed Switches and Circuit Breakers".
2. Sealed transformers shall comply with requirements of Division 26 Section 262200 "Low-Voltage Transformers".

F. Ratings: The service pedestal shall be rated for operation at 10K minimum (AIC) amps interrupting capacity. The provided documentation shall list circuit breaker combinations and those to be used for de-rated operation for series ratings. Circuit breakers shall be panel labeled with engraved name plates.

G. Finish: Architect/Owner shall select finish from standard factory finish options.

H. Listings: Pedestals shall be of NEMA Type 3R weatherproof construction and shall be UL listed as "Enclosed Industrial Control Equipment".

PART 3 - EXECUTION

3.1. EXCAVATION

A. Provide responsibility for all demolition, excavation and backfilling required to install foundations for commercial pedestals.

B. After completion of pedestal installation, return all ground and pavement surfaces to original condition or to conditions indicated on the drawings. This includes all sidewalks, curbs, streets, parking areas, lawns, shrubs, etc.

3.2. PREPARATION

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

3.3. INSTALLATION

A. Identify pedestals according to Division 26 Section 260553, "Identification for Electrical Systems".

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

C. Install pedestals as indicated on the Drawings, in accordance with Manufacturer's published instructions.

D. Provide working clearances in conformance with NFPA 70.

E. Provide minimum 6-inch high concrete pad for outdoor pedestals. Refer to Division 26 Section 260500, "Common Work Results for Electrical" for installation requirements. Use manufacturer-approved mounting brackets for securing pedestals to concrete equipment pads.

F. Set pedestals plumb and level.

G. Seal conduits turning up into pedestals with foam duct sealant specified in Division 26 Section 260500, "Common Work Results for Electrical".

3.4. GROUNDING

A. Comply with Division 26 Section 260526, "Grounding and Bonding for Electrical Systems", for materials and installation requirements.

B. Provide two (2) ground rods for each pedestal as detailed on the Contract Drawings.

C. Ground and bond separately derived systems (i.e. transformers) per National Electrical Code Article 250.30. Provide supply-side bonding jumper from transformer to first disconnecting means or overcurrent device after the transformer.

3.5. FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection:

1. Inspect for defects and physical damage, labeling, and compliance with requirements of drawings and schedules.
2. Clean pedestals using Manufacturer's approved methods and materials.
3. Verify that equipment nameplates are installed and accurate.
4. Verify that identification nameplates are installed.
5. Verify that arc flash hazard labels are installed.
6. Check mounting, anchorage, clearances, and alignment and fit of components.
7. Check tightness of bolted electrical connections with calibrated torque wrench.
8. Refer to manufacturer's instructions for proper torque values.
9. Verify that neutral bar is bonded to ground bar with appropriately sized bonding jumper.
10. Verify that equipment ground bar is bonded to pedestal enclosure.
11. Test Labeling: On satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.

B. Electrical Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Testing Agency: Provide services of a qualified independent testing agency to perform specified testing. Provide set of Contract Documents to test organization. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in the original Contract Documents.
2. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.
3. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A and UL 486B.
4. Protective Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system configuration and parameters. Where discrepancies are found, recommend final protective device ratings and settings. Use accepted ratings or settings to

make the final system adjustments.

5. Make continuity tests of each circuit. Refer to Division 26 Section 260519, "Low-Voltage Electrical Power Conductors and Cables" for testing specific to feeder conductors.
6. Perform ground resistance test on system and equipment ground connections
7. Test main and branch over-current protective devices.
8. Infrared Scanning: Perform an infrared scan of all electrical connections in each pedes as follows:

    a. Remove equipment covers so terminations are accessible to scanning.
    b. Use an infrared scanning device designed to measure temperature or to significant deviations from normal values.
    c. Provide calibration record for device.
    d. Compare test results with specified performance or manufacturer 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 testing and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.
10. Submit all test reports to the Architect for review and approval.
11. Provide copy of all test reports in the O&M manual.

3.6. CLEANING

A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

B. Remove debris from pedestals and ensure complete installation is left in neat and finished condition.

END OF SECTION 262716

SECTION 262726 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. Tamper-Resistant receptacles.
5. Weather-Resistant receptacles.
6. Toggle 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. TR: Tamper-Resistant.

D. 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.

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. GFCI Receptacles: One for each ten installed, but not less than two.
2. USB Charger Receptacles: One for each ten installed, but not less than two.

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. Emergency Pushbuttons:

   a. Safety Technology International, Inc. (STI)
   b. Square D Company

3. Crouse-Hinds Retractable Cord Reels:

   a. Hubbell Inc., Wiring Devices Division
   b. Pass & Seymour/Legrand
   c. Reelcraft Industries
   d. Ericson Manufacturing Company
   e. Appleton Electric Company

4. Emergency Pushbuttons:

   a. Safety Technology International, Inc. (STI)
   b. Square D Company
   c. Crouse-Hinds

2.2. STRAIGHT BLADE RECEPTACLE

A. General Requirements

1. Straight blade receptacle shall have the following basic features:

   a. One-piece brass mounting strap with integral ground for low resistance of fault current.
   b. Auto-ground clip to assure positive ground.
   c. Impact-resistant nylon face and thermoplastic base housing.
      #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. Duplex Tamper-Resistant USB Charger Receptacles

1. Decorator style tamper-resistant duplex convenience receptacles shall be heavy-duty, specification grade, 20A, 125V, with the following features:

    a. 5Vdc output, minimum 3.1 amperes
    b. One (1) USB Type "A" port and one (1) USB Type "C" port.
    c. "TR" marking on face as required by UL standard.
    d. Thermoplastic dual mechanism shutter 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 USB20AC5, Pass & Seymour TR20ACUSB, or approved equal by acceptable manufacturer.

D. Duplex Tamper-Resistant USB Charger Receptacles with 5V Power Outlet

1. Decorator style tamper-resistant duplex convenience receptacles shall be heavy-duty, specification grade, 20A, 125V, with the following features:

    a. One USB Type 2.0 port, 3 Amperes, 5 Volts DC.
    b. Green LED indicator to show USB power available.
    c. Switchable integrated power supply, 3 Amperes, 5 Volts DC.
    d. Rear 5 Volts DC leads for powering 5V components
    e. "TR" marking on face as required by UL standard.
    f. 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 1.1/2.0/3.0 devices, including Apple® products.
5. Hubbell AVPS15220 or approved equal by acceptable manufacturer.

E. Dual-Controlled Plug Load Controllable Duplex Tamper-Resistant Receptacles

1. Dual-controlled plug load controllable 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 NEC Article 410.6(E), CA Title 24, and ASHRAE Energy Efficiency Standard 90.1.
    b. "TR" marking on face as required by UL standard.
    c. 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 HBL5362C2, Pass & Seymour 5362CD Series, or approved equal by acceptable manufacturer.

F. Corrosion-, Dust-, and Moisture-Resistant Duplex Convenience Receptacles

1. Corrosion-, dust-, and moisture-resistant duplex convenience receptacles shall be heavy-

duty, specification grade, 20A, 125V, with the following features:

a. Nickel plated steel device strap.
b. Copper “hot” side termination screws.
c. Nickel plated “neutral” side termination screws.
d. Stainless steel bracket screws.
e. Integral neoprene gasket protecting device slots.
f. UV-resistant yellow 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. Pass & Seymour CR6307, or approved equal by acceptable manufacturer.

G. Tamper-Resistant Recessed Single Receptacles

1. Tamper-resistant recessed single convenience receptacles shall be extra heavy-duty, specification grade, 20A, 125V, with the following features:

a. Recessed receptacle with integral nylon faceplate.
b. “TR” marking on face as required by UL standard.
c. 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 RR151CH*TR, Pass & Seymour 53713TR , or approved equal by acceptable manufacturer.

H. 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 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 20GFTR, or approved equal by acceptable manufacturer.

C. Weather-Resistant Duplex GFCI Receptacles

1. Weather-resistant tamper-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.
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 and Federal Specification W-C-596.
3. Hubbell GFWRST20, Pass & Seymour 2097TRWR, 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 [illegible] dissipati[illegible]
f. Nickel-plated steel strap with integral ground.
g. Auto-ground clip to assure positive ground[illegible]

B. Toggle Switches

1. Toggle switches shall be quiet-type, extra hea[illegible] duty, [illegible]epower-rated, industrial grade, 120/277V, 20A: Comply with NEMA [illegible]1, U[illegible] and Federal Specification W-S-896.
2. Hubbell HBL1221 (single-pole), HBL12[illegible] (two-pole), HBL1223 (three-way), HBL1224 (four-way), Pass & Seymour [illegible]0AC[illegible] (sin[illegible]-pole), PS20AC2 (two-pole), PS20AC3 (three-way), PS20AC4 (four-way), [illegible]pprov[illegible] equal by acceptable manufacturer.

C. Illuminated Toggle Switches (L[illegible] On with Load Off)

1. Illuminated tog[illegible] switc[illegible] shall be quiet-type, extra heavy-duty, horsepower-rated, industrial grade, 12[illegible]V, 20A, with clear illuminated toggle, lighted with load off.
2. Comply wi[illegible]EMA [illegible]D 1, UL 20 and Federal Specification W-S-896.
3. Hubbell [illegible]HBL1[illegible]ILC (single-pole), HBL1223ILC (three-way), Pass & Seymour PS20A[illegible]1-CSL ([illegible]gle-pole), PS20AC3-CSL (three-way), or approved equal by accept[illegible]le manufa[illegible]urer.

D. Pilot [illegible]ghted S[illegible]itches (Light On with Load On)

1. [illegible]ot lighted switches shall be quiet-type, extra heavy-duty, horsepower-rated, industrial g[illegible] 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.

E. 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 TIMER SWITCHES

A. Digital Preset Timer

1. Description: Electronic automatic shut-off wall timer.
2. Features:

a. Adjustable Time Delay: 15/30/60 minutes, 2/4 hours.
b. Single button timer selection
c. LED indication
d. Silent operation
e. Requires neutral conductor
f. cULus listed.
g. Conforms to NEMA WD-1 and WD-6.

3. Ratings:

a. 0-1800W, 1/4HP at 120 VAC, 60 Hz.

4. Loads:

a. Lighting: Incandescent, fluorescent, compact fluorescent (CFL), magnetic low-voltage (MLV), electronic low-voltage (ELV).
b. Motors: Up to 1/4 horsepower.

5. Basis of Design: Intermatic Catalog No. EI215 (finish to match other wiring devices 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 device listing:

1. Wiring Devices connected to Normal Power System: White.
2. Wiring Devices connected to Computer Power System: Gray.
3. Wiring Devices connected to Emergency Power System: Red.
4. Special Receptacles: Black.
5. Wiring devices located on stage: 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. Material for Stage/Platform: Unbreakable nylon, black finish.
4. Plate-Securing Screws: Metal with heads colored to match plate finish.

B. Device plates shall be factory engraved to clearly identify receptacles on GFCI-protected circuits. Lettering shall be ¼" high, filled with black paint and read "GFCI".

C. Device plates shall be factory engraved to clearly identify receptacles which are on emergency circuits. Lettering shall be ¼" high, filled with red paint and read "EMERGENCY".

D. 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.

E. Expandable Covers for Receptacles in Damp and Wet Locations: Low-profile, 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". Cover shall expand from 2 inches to 3/5 inches for while-in-use needs. 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. Horizontal Receptacles – Hubbell-Taymac Model No. MX4380, or approved equal.
2. Vertical Receptacles – Hubbell-Taymac Model No. MX4280 or approved equal.

F. 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.

G. Dustproof Covers for Devices in Hard-Use Areas: Brushed 302 stainless steel dust covers designed for corrosive environments and hard-use areas, with stainless steel springs.

1. Duplex Receptacles – Pass & Seymour Model WP8 (vertical), Pass & Seymour Model WPH8 (horizontal), or approved equal by Hubbell, or other listed manufacturer.
2. GFCI Receptacles – Pass & Seymour Model WP26 (vertical), Pass & Seymour Model WPH26 (horizontal), or approved equal by Hubbell, or other listed manufacturer.]
3. Toggle Switches – Pass & Seymour Model WP1 (one gang), Pass & Seymour Model WP2 (two gang), or approved equal by Hubbell, or other listed manufacturer.
4. Network Light Switches - Pass & Seymour Model WP26, or approved equal by Hubbell, or other listed manufacturer.

H. Lockable Dustproof Covers for Devices in Hard-Use Areas: Brushed 302 stainless steel dust covers designed for corrosive environments and hard-use areas, with stainless steel springs and keyed cam-style lock.

1. Duplex Receptacles – Pass & Seymour Model WP8L, or approved equal by Hubbell, or other listed manufacturer.
2. GFCI Receptacles – Pass & Seymour Model WP26L, or approved equal by Hubbell, or

other listed manufacturer.

3. Toggle Switches – Pass & Seymour Model WP1L, or approved equal by Hubbell, or other listed manufacturer.
4. Network Light Switches - Pass & Seymour Model WP26L, or approved equal by Hubbell, or other listed manufacturer.

2.9. EMERGENCY PUSHBUTTONS

A. General:

1. Emergency pushbuttons shall be Stopper Station with Mini Stopper cover, 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) set of gold-plated contacts.

C. Construction:

1. Housing shall be molded of polycarbonate rated for temperature range of -40 degrees to 250 degrees Fahrenheit.
2. Housing color shall be yellow unless otherwise indicated.
3. Pushbutton shall be provided with stainless steel backplate and matching polycarbonate spacer (as required), both having a 5VA flammability rating.

D. Labeling:

1. Pushbuttons shall be provided with a vinyl label that is customized to suit each application, including, but not limited to the following:

a. "Emergency Power Off"
b. "Water Heater Shut-Down"
c. "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. Integral 105 dB horn.

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 (1) year guarantee on electrical, mechanical and electronic components.

2.10. CORD AND PLUG SETS

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

1. Cord: Rubber insulated, stranded copper conductors, with type SOW A jacket. Green insulated grounding conductor, and adequate for rating ampacity plus a minimum of 30 percent.
2. Plug: Nylon body and integral strain relief clamping jaws. Match cord and receptacle type for connection.

2.11. RETRACTABLE CORD REELS - LIGHT DUTY

A. Description: Factory-fabricated retractable cord reel with receptacle connector body and the following features:

1. Cord: Type "SJT" cord with three (3) 16 AWG conductors, white jacket.
2. Receptacle connector body: Nylon body with three (3) NEMA 5-15R grounded receptacles, white finish.
3. Removable bracket allows reel to be disengaged from mount.
4. Steel housing, compact size, white finish.
5. Adjustable cable stop.
6. Automatic ratchet lock holds cord at desired length.
7. Attached plug for power cord.
8. Maximum Wattage: 1,250 watts.

B. Basis of Design: Hubbell HBLC30163TT Series

2.12. RETRACTABLE CORD REELS - HEAVY DUTY

A. Description: Factory-fabricated retractable cord reel with receptacle connector body and the following features:

1. Corrosion-resistant cast aluminum construction, white powder coat finish.
2. Factory-assembled, modular type collector ring and brush block assembly.
3. Lifetime lubricated bearings.
4. Removable cover(s) for access to springs and ring/brush assembly.
5. Adjustable, four-roller cord outlet guide.

6. Built-in cord locking ratchet to hold cord at desired length. Ratchet can be disengaged to provide constant cord tension.
7. Type SJO cord with conductors to match requirements (voltage, ampacity, quantity) of equipment being connected. 12/3 SJO unless otherwise indicated on the Cord Reel Schedule on the Contract Drawings.
8. Connector Ends: As indicated on the Cord Reel Schedule on the Contract Drawings, from the following options:

    a. Single straight blade receptacle, NEMA configuration as noted.
    b. Single twist-lock receptacle, NEMA configuration as noted.
    c. One (1) or two (2) 20A duplex receptacles in yellow or black outlet box
    d. GFCI module and one (1) 20A duplex receptacle in yellow outlet box
    e. GFCI module and two (2) 20A duplex receptacles in yellow outlet box

9. Receptacle connector body: Nylon body with integral cable clamping jaws and blade configuration to match equipment being connected.

B. Basis of Design: Hubbell inREACH Series.

2.13. RETRACTABLE CORD REEL ENCLOSURES

A. Description: Plenum-rated cord reel enclosures shall have the following features:

1. Steel enclosure, white powder coat surface finish, with brackets for mounting with threaded steel rod, and a hinged door with opening for cord reel end.
2. UL 2416 Listed; Compliant with plenum requirements per NEC Article 300.22
3. 75 lbs load capacity
4. 4 inch square electrical box included
5. Pre-punched knockout blue

B. Basis of Design: Hubbell SLIP BOX Series.

C. Provide enclosures for retractable cord reels in the kitchen under base bid, and in science and tech labs under alternates as indicated on the Retractable Cord Reel Schedule on the Contract Drawings.

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.

3.3. INSTALLATION – RECEPTACLES

A. Receptacles on emergency circuits shall be clearly identified, with a circuit label indicating panelboard and circuit number.

B. All 15 ampere and 20 ampere, 125 volt and 250 volt 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.

C. 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. Kitchens.
3. Rooftops.
4. Outdoors.
5. Within six (6) feet (1.8m) of sinks, plumbing fixtures and water piping.
6. Indoor wet locations.
7. Mechanical rooms, electrical rooms, shops, and similar areas where electrical hand tools or portable lighting equipment are to be used.

D. 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.

E. All non-locking type, 125 volt, 15 ampere and 20 ampere receptacles installed in childcare facilities shall be listed tamper-resistant receptacles in accordance with NEC Article 406.14. Refer to Division 26 Section 260500, "Common Work Results for Electrical" for the definition of Childcare Facilities.

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. IDENTIFICATION

A. Comply with Division 26 Section 260553, “Identification for Electrical Systems”.

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 each 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.

3.6. 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.

3.7. FIELD QUALITY CONTROL

A. Test wiring devices for proper polarity, continuity, short circuits, and ground continuity. Operate each device at least six times.

B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

C. Replace damaged or defective components.

3.8. CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 262726

SECTION 262813 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 tests 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 limits 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

C. Record the equipment nameplate rating and actual fuse rating and location of fuses on the record drawings.

D. Provide a complete short circuit coordination study report required to select fuses to protect equipment. Refer to Division 26 Section 260573, “Overcurrent Protective Device Coordination Study” for additional information.

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. (Provide three (3) of each 601 Ampere and larger fuse type and size installed.)
2. Fuse Pullers: Furnish two (2) fuse pullers.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

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

1. Cooper Industries Inc. Bussmann Div.
2. Edison Electric Mfg, Co. Inc.
3. General Electric Co; Wiring Devices Div.
4. Mersen (formerly Ferraz Shawmut)
5. Tracor, Inc; Littelfuse, Inc. Subsidiary

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 be changed without tools
3. Door has quarter-turn key lock; two keys included
4. Retractable spring hinge
5. Two or 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 APPLICATION

A. Main Service: Class L, fast acting, 600 Volt, 601-6000 Amp, and 300 kA interrupting rating. Fuses shall be time delay and shall hold 500 percent of rated current for a minimum of four (4) seconds, clear 20 times rated current in 0.01 second or less, UL listed.

B. Main Feeders: Class J, time delay, 600 Volt, 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.

C. Motor Branch Circuits: Class RK1, time delay, 250 Volt or 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 manufacturer's published data and recommendations.

D. Other Branch Circuits: Class RK1, non-time delay, 250 Volt or 600 Volt, 0-600 Amp, and 300 kA interrupting rating.

E. Control Circuits: Class CC, current limiting rejection type, rated 30 amperes, 600 volts, and 200-kA interrupting rating.

F. Provide fuses of type and rating recommended by equipment manufacturer for packaged and/or specialized equipment.

G. Six hundred ampere or less, installed ahead of breaker: Class RK1, time delay.

H. 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.

I. Panelboards: The manufacturer shall supply equipment utilizing fully-rated and listed components. This equipment shall be tested, listed, and labeled for the available short-circuit current.

3.3. INSTALLATION

A. Fuses shall not be installed until equipment is ready to be energized. This measure prevents fuse damage during shipment of the equipment from the manufacturer to the job site, or from water that may contact the fuse before the equipment is installed. Final tests and inspections shall be made prior to energizing the equipment. This shall include a thorough cleaning, tightening, and review of all electrical connections and inspection of all grounding conductors. All fuses shall be furnished and installed by the electrical contractor. All fuses shall be of the same manufacturer.

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 the main electrical room in each mechanical room and each mechanical penthouse. 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 fr[illegible] door of cabinet(s). Refer to Division 26 Section 260553, “Identification for Electrical Sys[illegible]s” f[illegible] nameplate requirements.

END OF SECTION 262813

SECTION 262816 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and 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 262726, "Wiring Devices" for toggle switches used as disconnecting means.
2. Division 26 Section 262813, "Fuses" for fuses in fusible disconnect switches.

C. Provide method of disconnection for appliances, motors, equipment, etc., as required to comply with NEC (including Article 430-C, and Article 440-D).

1.3. 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.

E. Field test reports indicating and interpreting test results.

1.4. QUALITY ASSURANCE

A. 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 (NETA).

1. Testing Agency's Field Supervisor: Person currently certified by NETA or the National Institute for Certification in Engineering Technologies, to supervise on site testing specified in Part 3.

B. Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.

C. Comply with NFPA 70 for components and installation.

D. 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, UL [illegible] - Molded Case Circuit Breakers and Circuit Breaker Enclosures, NEMA 250 - Enclosures for Electrical Equipment.
4. Comply with ANSI and NEMA Standards for materials ratings.

1.5. 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. 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. 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. General Electric (GE)
d. Siemens Energy & Automation, Inc.

2. Enclosed Circuit Breakers:

a. Square D Company. (Basis of Design)
b. Eaton Corporation; Cutler Hammer.
c. General Electric (GE)

d. Siemens Energy & Automation, Inc.

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 4X, Type 316 stainless steel, attached by molded hinges and stainless steel hinge pins.
2. Kitchen Areas: Type 4X, Type 316 stainless steel, attached by molded hinges and stainless steel hinge pins.
3. Corrosive Locations (e.g. Natatorium, greenhouses, etc.): Type 4X, non-metallic, fiberglass reinforced polyester.

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.

1. Outdoor Locations: Type 4X, Stainless steel.
2. Kitchen Areas: Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: Type 4.
4. Corrosive Locations (e.g.: Natatoriums, Greenhouses, etc): Type 4X non-metallic.

K. Provide full capacity neutral lug, or 200 full capacity neutral for non-linear loads, and equipment grounding lug.

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 not 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 shall be labeled for service entrance use, if so required, where used for service entrance whether called for or not.

I. 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.

J. 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 260553, "Identification For Electrical Systems". 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 branches).

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 ratings.
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.

B. Electrical Tests: Upon installation of disconnect switches and enclosed circuit breakers and before electrical circuitry has been energized, provide the following minimum inspections and tests according to manufacturer's written instructions to ensure components 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.

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.

B. Set field adjustable circuit breaker trip ranges as recommended in overcurrent protective coordination study specified in Division 26 Section 260573, "Overcurrent Protective Device Coordination Study".

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 262816

SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SUMMARY

A. This Section includes AC motor-control devices rated 600 V and less that are supplied as enclosed units.

B. Related Sections include the following:

1. Division 26 Section 260500, "Common Work Results for Electrical" for Mechanical - Electrical coordination requirements.
2. Division 26 Section 260500, "Common Work Results for Electrical" for general materials and installation methods.
3. Division 26 Section 260553, "Identification for Electrical Systems" for labeling materials.
4. Division 26 Section 262813, "Fuses" for fuses installed in combination magnetic motor controllers with fusible disconnect switches.

1.3. DEFINITIONS

A. CPT: Control power transformer.

B. N.C.: Normally closed.

C. N.O.: Normally open.

D. OCPD: Overcurrent protective device.

1.4. 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. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

D. Submit a schedule of equipment to indicate motor controller ratings, sizes, and other electrical characteristics for each item of equipment.

1.5. 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 sin manufacturer.

C. Comply with NFPA 70.

D. Listing and Labeling: Provide motor controllers specified in this Section that a sted a labeled.

1. The Terms Listed and Labeled: As defined in the National Ele ode, rticle 100.
2. Listing and Labeling Agency Qualifications: A Nationally R ognized sting Laboratory as defined in OSHA Regulation 1910.7.

E. UL Compliance: NEMA ICS 2, Industrial Control Devices rs a semblies.

1.6. DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clea space ith uniform temperature to prevent condensation. Protect enclosed contro s fr posure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enc controllers to protect them from weather, dirt, dust, corrosive substances, and ical damage. Remove loose packing and flammable materials from inside controllers; inst temp ary electric heating, with at least 250 W per controller.

1.7. PROJECT CONDITIONS

A. Environmental imitations Rate equipment for continuous operation under the following conditions unle otherwis dicated:

1. Amb t Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 10 deg F (40 deg C).
2. itude: Not exceeding 6600 feet (2010 m).

1.8. ANTY

A. eneral 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. 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.

1.9. 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 those specified, any increase in electrical feeders, conduits, circuit breakers, etc., including increased labor cost shall be the responsibility of the Contractor.

F. Provide branch circuits for all motors to the starting equipment, 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 circuit 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. Fuses for Fusible Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
4. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.
5. Overload Relays: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
6. 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. General Electric (GE).
4. Siemens Energy and Automation, Inc.
5. Allen-Bradley Company; Industrial Control Group.
6. Crouse-Hinds ECM; Cooper Industries, Inc. Division.

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 or corrosive 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 or corrosive 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. COMBINATION MAGNETIC MOTOR CONTROLLERS

A. Description: Combine magnetic motor controllers with fusible switch disconnect in common enclosure.

1. Magnetic Motor Controllers: NEMA ICS 2, AC general-purpose Class A, full-voltage, non-reversing, across-the-line magnetic controller for induction motors rated in horsepower.
2. Fusible Switch Assemblies: NEMA KS 1, enclosed knife switch with externally operable handle and visible blades. Switch shall have a color-coded external operated handle. Operating handle shall give positive visual indication of "on" and "off" with red and black color-coding. Switch shall have fuse clips to accept rejection-type dual element, current-limiting, time-delay fuses, as specified in Division 26 Section "Fuses".

B. Control Circuit: Coordinate with Automatic Temperature Control Contractor; obtained from integral control power transformer.

C. Coil: Encapsulated type.

D. Poles: As indicated.

E. Size: NEMA size 1, unless otherwise indicated.

F. Contacts: Totally enclosed, double-break, silver-cadmium-oxide power contacts. Contact inspection and replacement shall be possible without disturbing line or load wiring.

G. Wiring: Straight-through wiring with all terminals clearly marked.

H. Overload Relay: NEMA ICS 2. Provide with sensors in each phase matched to nameplate full-load current of specific motor to which they connect, and with appropriate adjustment for motor duty cycle.

1. Solid State: Trip current rating will be established by selection of overload relay and shall be adjustable (3 to 1 current range). The overload shall be self-powered, provide phase loss and phase unbalance protection, have a permanent tamper guard, and be ambient insensitive. It shall be available in Trip Class 10 or Class 20 and have a mechanical test function.
2. Outputs: Provide normally closed (N.C.) auxiliary contact.
3. Reset: Unit shall offer both manual reset and remote reset using an external module.

I. Options and Features:

1. Control Power Transformers: Include a control power transformer with adequate capacity to operate connected pilot light, indicating and control devices. Provide fused secondary protection and bond un-fused leg of secondary to enclosure.
2. Auxiliary Contacts: Provide two normally open (N.O.) and two normally closed (N.C.) auxiliary contacts in each starter in addition to the standard normally open (N.O.) sealing contact.
3. Selector Switches: Rotary type, Hand-Off-Automatic (H-O-A) selector switch. All switch positions shall be maintained contact.
4. Cover Mounted Indicating Lights: Green "Power Available" and red "Running" LED type

indicating lights. "Power Available" indicating light shall be connected at the load side of the fused secondary terminals of the control power transformer. "Running" indicating light shall be connected through one normally open (N.O.) auxiliary control contact. Indicating lights connected to the start button or across the load side of starters will not be acceptable. Indicating lights shall be equipped with individual legend plates supplied by the manufacturer.

5. Pilot Device Contacts: NEMA ICS 2, Form "Z".

J. Furnish Square D, Class 8538 Type S, or approved equal.

2.5. ENCLOSURES

A. Description: All motor controllers shall be mounted in enclosures flush or surface mounted as required. Provide flush-mounted enclosures for motor controls in finished locations.

B. Enclosures shall comply with requirements of NEMA 250 – "Enclosures for Electrical Equipment", and NEMA ICS 6 – "Enclosures Standard".

C. Enclosures shall be provided in accordance with the following requirements in order to meet environmental conditions at the installed location of each motor controller.

1. Dry, Interior Locations: NEMA Type 1.
2. Damp or Wet Locations: NEMA Type 4X, stainless steel.
3. Kitchen Areas: NEMA Type 4X, Stainless Steel.
4. Corrosive Areas (e.g. Natatoriums, Greenhouses, etc.): NEMA 4X, Nonmetallic.

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 devices 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 260529, “Hangers and Supports for Electrical Systems”.

3.3. IDENTIFICATION

A. Identify motor-control components and control wiring according to requirements specified in Division 26 Section 260553, “Identification for Electrical Systems”.

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 260519, “Low-Voltage Electrical Power Conductors and Cables”.

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

C. Connect hand-off-automatic switch and other automatic control devices where 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 overload types and ratings in devices with 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 262913

SECTION 263213 - ENGINE GENERATORS

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 packaged engine-generator sets for a Class 48, Type 10, Level 1 emergency power supply system with the following features:

1. Diesel engine.
2. Unit-mounted cooling system.
3. Unit-mounted control and monitoring.
4. Starting battery and battery charger.
5. Muffler and exhaust piping.
6. Remote annunciator.
7. Outdoor enclosure.

B. Related Sections include the following:

1. Division 26 Section 26360 "Transfer Switches", for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3. DEFINITIONS

A. Class: The minimum amount of hours that the EPSS can operate at its rated load without being re-fueled. For example, a Class 48 system must operate for a minimum of 48 hours.

B. Emergency Systems: Systems legally required and classed as emergency by municipal, state, federal or other codes, or by any governmental agency having jurisdiction, which are intended to automatically supply illumination, power, or both, to designated areas and equipment in event of failure of the normal power supply.

C. EPSS: Emergency power supply system.

D. Level: There are two Levels defined by NFPA 110 for an EPSS. Level 1 is more stringent and is imposed when failure of EPSS equipment could result in loss of human life or serious injuries. Level 2 is used when failure of the EPSS is less critical to human life and safety.

E. LP: Liquid petroleum.

F. NFPA: National Fire Protection Association.

G. Operational Bandwidth: The total variation from the lowest to the highest value of a parameter over a range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

H. SPSS: Standby power supply system

I. Standby Rating: Power output rating equal to the power the generator set delivers continuously under normally varying load factors for the duration of a power outage.

J. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operating bandwidth, expressed in hertz (Hz) or cycles per second.

K. Type: The maximum amount of seconds that the load terminals of the EPSS transfer switch can be without acceptable electrical power. For example, a Type 10 EPSS must provide electrical power within 10 seconds.

1.4. SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.
2. Time-current characteristic curves for generator protective device.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring. Differentiate between factory-installed and field-installed wiring.

C. Qualification Data: For manufacturer.

D. Source quality-control test reports.

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

E. Field quality-control test reports.

F. Warranty: Special warranty specified in this Section.

G. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:

1. List of tools and replacement items recommended to be stored at Project for ready acce . Include part and drawing numbers, current unit prices, and source of supply.

1.5. EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and tha e pac ged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no less an one e ach.
2. Indicator Lamps: Two for every six of each type used, but fewer tha wo of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-a filters.
4. Belts: Two sets of each type.

1.6. QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's auth repres ative who is trained and approved for installation of units required for this Proje

1. Maintenance Proximity: Not mor an fo hours' normal travel time from In-staller's place of business to Project site.
2. Engineering Responsi : Preparation of data for vibration isolators and seismic restraints of engi skid mounts, including Shop Drawings, based on testing and engineering ana s of facturer's standard units in assemblies similar to those indicated for this

B. Manufacturer Q ificati A alified manufacturer. Maintain, within 200 miles (321 km) of Project site, a rvice cen capable of providing training, parts, and emergency maintenance repairs.

C. Sour Limita ns: Obtain packaged generator sets and auxiliary components through one source from ingl manufacturer.

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

E. mply with ASME B15.1.

F. Comply with NFPA 37.

G. Comply with NFPA 70.

H. Comply with NFPA 110 requirements for emergency power supply system level specified.

I. Comply with UL 2200.

J. Comply with ISO 8528.

K. Engine Exhaust Emissions:

1. Comply with EPA Tier 3 requirements and all applicable state and local government requirements.
2. Generators shall be factory certified to meet Environmental Protection Agency (EPA) New Source Performance Standards (NSPS).
3. Obtain DNREC air quality permit-to-construct for generator equipment, as required.

L. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1. Refer to generator schedule on the Contract Drawings for maximum noise level (dBA value).

1.7. PROJECT CONDITIONS

A. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: Minus 15 to plus 40 deg C.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 1000 feet (300

1.8. COORDINATION

A. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and form-work requirements shall be as specified in Division 03 Section 033000 "Cast-in-Place Concrete".

1.9. WARRANTY

A. Special Warranty: Manufacturer's comprehensive warranty in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period, including but not limited to materials, labor, travel, fuel, lodging, etc.

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

1.10. MAINTENANCE SERVICE

Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

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

1. Caterpillar; Engine Div.
2. Generac Power Systems, Inc.
3. Kohler Power Systems; Generator Division.
4. MTU Onsite Energy.
5. Onan/Cummins Power Generation; Industrial Business Group.

2.2. ENGINE GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted co ents wi out depending on concrete foundation; and have lifting attachments.

1. Rigging Diagram: Inscribed on me te pe ently attached to mounting frame to indicate lo-cation and lifting capa y of e fting ttachment and generator-set center of gravity.

C. Capacities and Characteristics:

1. Power Output Rati s: N inal ratings as indicated on the Contract Drawings.
2. Nameplates: F each system component to identify manufacturer's name and address, and mode erial number of component.

D. Generator Set P ormanc

1. S ady ate Volt e Operational Bandwidth: 3 percent of rated output voltage from no oad to f
2. Tran nt Voltage Performance: Not more than 20 percent variation for 50 percent step-lo in-crease or decrease. Voltage shall recover and remain within the steady-state erating band within three seconds.
3. S y-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, sys-tem shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3. ENGINE

A. Fuel: Fuel oil, Grade DF-2.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).

D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 microns and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:

1. Fuel oil, Grade DF-2

a. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
b. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Coolant Jacket Heater: Electric immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for heater capacity.

G. Governor: Adjustable isochronous, with speed sensing.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anti-corrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to full per-cent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.

J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

K. Starting System: 12 or 24-V electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle w[ith] ambient temperature at maximum specified in Part 1 "Project Conditions" Article
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from [en]gine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Adequate capacity within ambient temperature range specifi[ed] in Pa[rt] "Project Conditions" Article to provide specified cranking cycle at least thr[ee] times without recharging.
5. Battery Cable: Size as recommended by engine manufactu[rer] for cab[le] leng[th] indicated. Include required interconnecting conductors and connectio[n] accessories.
6. Battery Compartment: Factory fabricated of metal with acid[-re]sistant [fin]ish and thermal insulation.
7. Battery-Charging Alternator: Factory mount[ed] on en[gine] with solid-state voltage regulation and 35-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equ[al]izing a[nd] float-charging type. Unit shall comply with UL 1236 and include the f[ol]lowing [fe]atures:

a. Operation: Equalizing-ch[ar]ging [ra]te of 10[0] shall be initiated automatically after battery has lost charge[,] until an[d] adjust[ed] equalizing voltage is achieved at battery terminals. Unit shall the[n] automatically switched to a lower float-charging mode and shall continue to o[pe]rate in that mode until battery is discharged again.

b. Automatic Tem[p]erature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.

e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

f. Enclosure and Mounting: NEMA 250, Type 4X, wall-mounted cabinet.

2.4. DIESEL FUEL-OIL SYSTEM

Comply with NFPA 30.

B. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

C. Fuel Filtering: Remove water and contaminants larger than 1 micron.

D. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

E. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:

1. Tank level indicator.
2. Tank Capacity: As recommended by engine manufacturer for an uninterrupted period of operation as indicated on the Contract Drawings at 100 percent of rated power output of engine-generator system without being refilled.
3. Vandal-resistant fill cap.
4. Emergency Vent: Vent shall be designed for use on above-ground fuel storage tanks in accordance with applicable UL and NFPA Standards, to help prevent tanks from becoming over-pressurized or rupturing if exposed to fire. Vents shall be equipped with factory-installed mesh screens.
5. Containment Provisions: Comply with requirements of authorities having jurisdiction.
6. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
7. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
8. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.
9. Redundant High-Level Fuel Shutoff: Actuated by liquid-level sensor in tank to operate a separate motor device that disconnects pump motor. Sensor shall signal solenoid valve located in fuel suction line to close. Both functions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine-generator set.

F. Fuel Polishing System: Programmable, fully automated, in-tank maintenance system that removes particulate, separates water, conditions and stabilizes diesel fuel, eliminates microbial contamination, and ensures fuel remains clean and dry. System shall be mounted within generator enclosure.

1. Flow Rate: Flow rate shall be selected based on size of fuel storage tank, such that entire fuel sup-ply is cleaned weekly.
2. Primary Filter: 10 to 30 micron particulate filter and centrifugal water separator.
3. Fuel Conditioner: Inline conditioner.
4. Pump: Continuous duty helical spur gear type, 1/3HP.
5. System Controller: Smart system monitor with safety and alarm features, such as automatic pump shut-down, filter change, high pump vacuum, high water in bowl, pressure limits, and leaks.
6. Power: 12 or 24Vdc.
7. Plumbing: Stainless steel.
8. Inlets: 1/2” 37 degree flare in, 1/2" 37 degree flare out.
9. Construction: Powder coated aluminum back plate.
10. Provide Smart Fuel Polishing System (FPS) as manufactured by AXI International, or approved equal.

2.[illegible] CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates genera-tor-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch shall also shuts down generator set.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements

automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch shall also shut down generator set.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gauges shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

D. Indicating and Protective Devices and Controls: As required by NFPA 110 for system level specified, and the following:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Start-stop switch.
11. Overspeed shutdown device.
12. Coolant high-temperature shutdown device.
13. Coolant low-level shutdown device.
14. Oil low-pressure shutdown device.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Generator overload.

E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

F. Common Remote Audible Alarm:

1. Comply with NFPA 110 requirements for system level specified. Include necessary contacts and terminals in control and monitoring panel.

a. Overcrank shutdown.
b. Coolant low-temperature alarm.
c. Control switch not in auto position.
d. Battery-charger malfunction alarm.
e. Battery low-voltage alarm.

2. Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.

a. Engine high-temperature shutdown.
b. Lube-oil, low-pressure shutdown.
c. Overspeed shutdown.
d. Remote emergency-stop shutdown.
e. Engine high-temperature prealarm.
f. Lube-oil, low-pressure prealarm.
g. Fuel tank, low-fuel level.
h. Low coolant level.

G. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

H. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

I. Building Management System Connection: Provide Echelon LonWorks communication module for connection to building management system under Division 23.

2.6. GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, electronic-trip type, 100 percent rated; complying with NEMA AB 1 and UL 489.

1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: As indicated on the Contract Drawings.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integral with control and monitoring panel.

B. Generator Protector: Microprocessor-based unit that will continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt trip device in the generator disconnect switch shall open the switch to dis-connect the generator from load circuits. Protector shall perform the following functions:

1. Initiates generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

2.7. GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specifi

1. Adjusting rheostat on control and monitoring panel shall provide plus or m s 5 pe adjustment of output-voltage operating band.

I. Strip Heater: Thermostatically controlled unit arranged to maintain s ndi bove dew point.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseu indin

K. Subtransient Reactance: 12 percent, maximum.

2.8. ENGINE START MONITORING SYSTEM

A. Description: Engine start monitoring syst that rs the integrity/operability of engine start circuits from automatic transfer switches, d a omat lly starts engine-generator(s) when faults occur, with the following features:

1. System shall be capab onitoring up to eight (8) automatic transfer switches, including fire pump controll with tomatic transfer switches provided under Division 21.
2. Modules shall u a sta ine control wiring.
3. Generator module provide two (2) Form "C" contacts, one (1) for engine start and one (1) f g.
4. Gener r module all be equipped with status LEDs for each channel to determine system status g. channe isabled, wiring fault, engine start inactive, engine start active).
5. ansf witch dules shall be compatible with and wire into any contact-based engine start signa
6. Syst shall provide visual and audible notification of circuit faults at the generator and ote annunciator(s).

B. Provide ATS Engine Start Module 5101-ATS as manufactured by ASCO, or approved equal, at each automatic transfer switch including fire pump controllers with automatic transfer switches.

C. ovide Generator Engine Start Module 5101-GEN as manufactured by ASCO, or approved equal by listed manufacturer, at each engine-generator.

UTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof aluminum housing, wind resistant up to 100 mph (160 km/h). Instruments and control shall be mounted within enclosure.

1. Enclosure shall have a pitched roof to prevent standing water.
2. Lockable latching, hinged access panels/doors on each side and end of the enclosure shall be pro-vided for ease of inspection, maintenance, repair, etc… Routine inspection points for fluids shall be easily accessible by means of lockable latching, hinged door/panel.

Minimum of two (2) doors per side. Lockable latches shall be keyed alike.

3. Lockable latching, hinged access panels/doors shall be secured in the open position with hardware integral to the enclosure.
4. Access panels shall be removable by one person without tools.
5. Stainless steel hardware shall be used to provide corrosion protection for all hinges, latches, screws, etc…
6. External drains standards for fluids requiring routine replacement. External drains shall be capable of accepting NPT plug or other means to prevent accidental leaks or spills. Valves internal to the enclosure shall provide means of flow controls.
7. Enclosure shall achieve a Level 2 sound attenuation.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm proof and drainable louvers prevent entry of rain and snow.

C. Basic Electrical Package: Pre-wired AC power distribution of all factory installed features including block heater, two (2) GFCI protected internal 120 volt service receptacles, internal lighting, and commercial grade wall switch.

1. Load center powered by building source power and protected by a main circuit breaker. Load center shall be 208Y/120 three phase four-wire with 60-ampere main circuit breaker. Load center shall have surge protective device rated 120kA minimum.
2. AC power distribution installed in accordance with NEC and all wiring within EMT conduit.
3. DC Light Package: Skid mounted internal DC light package with four (4) vapor-proof LED fixtures within housing, arranged to illuminate controls and accessible interior. Battery drain limited with overcurrent protective and controlled through a 0-60 minute spring-wound, no-hold timer.
4. Convenience Outlets: Factory wired, GFCI.
5. Battery Charger: Mounting and pre-wiring of DC output and AC input. Battery charger located inside the enclosure and accessible through an access door.
6. Block Heater: Pre-wired AC input, 208-240 volt, single phase.

2.10. VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

2.11. FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.12. SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

PART 3 - EXECUTION

3.1. EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

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

3.2. INSTALLATION

A. Comply with packaged engine generator manufacturer's written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with elastomeric isolator pads on concrete equipment pad. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26 Section "Hangers and Supports".

D. Install packaged engine generator on cast-in-place concrete equipment base.
1. Comply with requirements for vibration isolation devices specified in this section.

E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

F. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions including the listing or labeling of UL listed products.

G. Provide branch circuits and motor starters, where required, from the standby power supply system for the generator set auxiliaries.

H. Provide and install emergency system conductors in a raceways system completely separate from other wiring. Control interconnection wiring shall be properly sized and run in a raceway separate from power cables.

3.3. CONNECTIONS

A. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

B. Connect engine exhaust pipe to engine with flexible connector.

C. Connect fuel piping to engines with a gate valve and union and flexible connector.

D. Connect wiring according to Division 26 Section 260519, "Low-Voltage Electrical Power Conductors and Cables."

E. Ground equipment according to Division 26 Section 260526, "Grounding and Bonding for Electrical Systems."

F. Verify that neutral-ground bonds do not exist at any point within engine generators connected to three-pole transfer switches.

G. Connect generator controller and/or remote annunciator to the fire alarm system as required to indicate the following signals:

1. Generator Running
2. Generator Fault.
3. Generator switch in non-automatic position.

H. Connect generator engine start monitoring system to modular automatic transfer switches and to generator and remote annunciators per manufacturer's instructions to indicate faults in start wiring system. Refer to Division 26 Section 263600, "Transfer Switches" for additional information.

3.4. IDENTIFICATION

A. Identify system components according to Division 26 Section 260553, "Identification for Electrical Systems".

3.5. FIELD QUALITY CONTROL

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

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to the following:

a. "Cold Start" test.
b. Single-step full-load pick-up test.
c. Four hour full-load test.

3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
c. Verify acceptance of charge for each element of the battery after discharge.
d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Exhaust Emissions Test: Comply with applicable government test criteria.
8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling air intake and discharge, at four locations on the property line, and compare measured levels with required values.
11. Provide full tank of fuel at completion of the on-site acceptance tests.

C. Coordinate tests with tests for transfer switches and related equipment concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge system and check for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and reinspect and retest as specified above.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6. DEMONSTRATION

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

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
2. Review data in maintenance manuals.
3. Review data in maintenance manuals.
4. Schedule training with Owner, through Architect, with at least seven days' advance notice.
5. Provide a minimum of four hours of instruction.

B. Coordinate this training with that for transfer switches specified in Division 26 Section 263600, "Transfer Switches".

END OF SECTION 263213

SECTION 263553 – VOLTAGE REGULATORS

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 power conditioning systems with line voltage regulation.

B. The systems specified herein shall include all the components necessary to provide the electrical power quality needed for the improved operation, performance, and reliability of commercial and industrial electronic equipment.

1.3. STANDARDS

A. The power conditioner/regulator shall be designed in accordance with applicable portions of the following standards:

1. American National Standards Institute (ANSI)
2. Institute of Electrical and Electronic Engineers (IEEE)
3. National Electric Code (NEC)
4. National Fire Protection Association (NFPA Article 70)
5. FCC Article 15, Section J, Class A
6. ANSI C62.41 Category B-3
7. UL Listed to Standard 1012
8. C-UL listed to CSA Standard C22.2, No. 107.1-01

1.4. SUBMITTALS

A. Product Data: Include data on features, components, ratings, dimensions, weight, and performance for each type of power conditioner/voltage regulator specified. Include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features.

Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.

B. Factory test results shall be provided to show compliance with the requirements. The manufacturer shall include test documentation which demonstrates compliance with the specified requirements at the continuous rated kVA load.

D. Field Test Reports: Indicate and interpret test results for tests specified in Part 3 of this Section.

E. Maintenance Data: For power conditioners/voltage regulators to be included in the Operation and Maintenance Manuals specified in Division 01 and Division 26 Section 260500, “Common Work Results for Electrical”.

F. Project Record Documents: Record actual power conditioner/regulator locations.

1.5. QUALITY ASSURANCE

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

1. Testing Agency's Field Supervisor: Person currently certified b he I national Electrical Testing Association or the National Institute for Certificatio Eng ering Technologies, to supervise on-site testing specified in Part 3 of tion.

B. Listing and Labeling: Provide transformers specified in this Sectio t are liste and labeled.

1. The Terms Listed and Labeled: As defined in NFP icle
2. Listing and Labeling Agency Qualifications: A N ionally R ognized Testing Laboratory as defined in OSHA Regulation 1910.7.

1.6. DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary he co ing manufacturer's written instructions within the enclosure of each ventilated-type unit roughou periods during which equipment is not energized and is not in a space that is conti y under normal control of temperature and humidity.

B. Store and protect equipm n a d tion with uniform temperature. Cover ventilation openings to keep dust out.

1.7. WARRANTY

A. Genera arranty warranty specified in this Article shall not deprive Owner of other rights Own may h e under other provisions of the Contract Documents and shall be in addition to, and run c ur nt with, other warranties made by Contractor under requirements of the Contract Docume

B. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for one (1) year from date of installation.

ART 2 RODUCTS

MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, supply equipment from one of the following manufacturers: No other manufacturers are acceptable.

1. Controlled Power Company (Basis of Design).
2. Square D Company.
3. Eaton/Cutler-Hammer.
4. General Electric (GE).

5. Siemens Energy & Automation, Inc.
6. Hammond Power Systems

2.2. POWER CONDITIONERS WITH VOLTAGE REGULATION

A. Description: Power conditioning shall be accomplished through use of an integral three (3) phase copper wound, triple shielded, low output impedance isolation transformer. Integral transient voltage surge suppression shall be included to meet and exceed ANSI/IEEE recommendations for surge voltages in AC power circuits. Line voltage regulation shall be as specified herein, providing one (1) cycle correction of under and over voltage conditions. The regulator shall incorporate microprocessor control, digital processing and independent phase regulation to provide the specified voltage, without any voltage over or under-shoots.

B. Input Specifications:

1. The nominal AC input voltage rating of the power conditioner/regulator shall be 480VAC, 3 phase, unless otherwise indicated on the Contract Drawings.
2. The nominal operating frequency shall be 60 hertz +/- 3 hertz.

C. Output Specifications:

1. The nominal AC output voltage shall be 208/120 VAC, wye derived, unless otherwise indicated on the Contract Drawings.
2. The output impedance shall be 3-4% typical.
3. The power conditioning transformer shall include seven (7) full capacity taps per phase, allowing for the tight output voltage regulation specified.
4. The power conditioning transformer shall provide a continuous duty, full load output power of 50 kVA, unless otherwise indicated on the Contract Drawings.

D. Performance Specifications:

1. Input voltage range shall be +10 / -20% with the output voltage regulated to +/- 3% typical.
2. Response time shall be less than ½ cycle.
3. Correction time shall be within 1 cycle.
4. The output voltage of the power conditioning transformer shall drop no more than 2.5%, when stepping from no load to full load.
5. Less than 1% THD shall be added to the output waveform under any dynamic linear loading conditions presented to the system.
6. Input power factor shall be greater than .99 with a resistive load and not reflect any triplen harmonics to the utility under non-linear loads.
7. The overload rating for the power conditioner/regulator shall be 200% continuous load rating for 30 seconds, 1,000% for 1 cycle.
8. Common mode noise attenuation shall be 146 dB minimum.
9. Transverse mode noise attenuation shall be 3 dB down at 1,000 hertz, 40 dB down per decade below 50 dB with a resistive load.
10. Efficiency shall be 96-97% typical, excitation losses shall be less than 1.5% of the kVA.
11. The power conditioner/regulator system shall exhibit a MTBF greater than 100,000 hours.

E. Main Input Circuit Breaker:

1. A main input molded case, thermal magnetic circuit breaker, rated at 125% of the full continuous load input current at the nominal input voltage, shall be furnished as an integral

part of the unit.

F. Output Circuit Breaker:

1. Provide one (1) output molded case, thermal magnetic circuit breaker, rated at 1[illegible] amperes, 208VAC, 3 phase.

G. Standard Monitoring:

1. Alert Light: An indicator light shall show if the output has been disabled by one of the following conditions:

   a. Transformer over-temperature
   b. SCR thermal over-temperature

2. Indicating Lamps: Output ON indicating lamps shall be provided for each phase.

H. Main Transformer Construction:

1. The transformer windings shall be of all copper conductor construction with separate primary and secondary isolated windings.
2. Fully processed, low carbon, silicon transformer steel shall be utilized to minimize losses and provide maximum efficiency. Flux density shall not exceed 14k gauss.
3. Class N (200° C) insulation shall be utilized throughout with 115° C temperature rise.
4. The transformer shall have multiple (three) copper shields to minimize inner winding capacitance, transient and noise coupling between primary and secondary windings. Inner winding capacitance shall be limited to .001 pF or less.

I. Cabinet Construction:

1. Design shall allow for front access to the status lights, input circuit breaker, serviceable parts, output circuit breaker(s), bypass switch, and metering. No side or rear access required for system installation, operation or service.
2. Input and output terminations shall be front access. Input terminations shall be made directly to the main input circuit breaker and the input ground terminal provided. Output terminations shall be made to the specified output circuit breaker(s) and neutral & ground copper bus provided.
3. Conduit landing plates shall be provided to permit top and/or bottom entry for input and output power connections.
4. Ventilation shall originate from the front of the cabinet and exhaust through the top of the cabinet.
5. Electronic control section shall be isolated from transformer section and power terminations.
6. Transformer section shall be designed for natural convection cooling.
7. Cabinet shall be NEMA 1 rated and constructed using a 12 gauge steel frame with 10 gauge steel floor mounting channels.
8. Exterior panels shall be pre-treated and powder-coat painted with manufacturer's standard color.

J. Environmental:

1. Temperature: The power conditioner/regulator system shall be required to operate without overheating in an ambient temperature range of -20°C to +40°C.
2. Humidity: The power conditioner/regulator system shall operate in a relative humidity of 0-95% non-condensing.

3. Altitude: The power conditioner/regulator system shall operate up to 5,000 feet above sea level without de-rating.
4. Audible noise: Maximum allowable noise shall not exceed 50 dba at 1 meter distance.

K. Manual Bypass:

1. A manually operated rotary switch shall provide bypassing of the regulator portion of the system. The regulator shall be either on-line or bypassed with one turn of the switch. The transformer, high frequency filtering, and electrical noise suppression shall remain in the circuit when in the bypass mode.

L. Digital Metering:

1. The power conditioner/regulator system shall be equipped with a digital input and output meter(s), flush-mounted on the front of the unit for ease of operation and viewing.
2. The digital meter(s) shall measure and display voltage, current, kVA, kVAh, kW, kWh, kVARs, kVARh, power factor, frequency, and % THD.
3. The meter(s) shall include a % load bar, limits exceeded alarm, and RS485 communication using MODBUS or DNP 3.0 protocols.

M. Red LEDs (one per phase) shall be provided to indicate if the supply voltage exceeds the specified input range of the regulator.

N. Basis of Design: Power Processor Series 90F, as manufactured by Controlled Power Company.

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 power conditioners/regulators 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 power conditioners/regulators in accordance with NECA SI, as indicated on the Drawings, and Manufacturer's published instructions, at locations as indicated on the Drawings.
1. Securely anchor power conditioners/regulators to concrete pad with vibration isolators.
2. Provide working clearances in conformance with NFPA 70.
3. Provide primary and secondary protection using circuit breakers as specified herein.

F. Set power conditioners/regulators plumb and level.

G. Use minimum two (2) foot length flexible conduit for connections to power conditioner/regulator case. Make conduit connections to side panel of enclosure.

H. Mount power conditioners/regulators on vibration isolating pads suitable for isolating power conditioner/regulator noise from building structure.

I. Provide minimum 4-inch high concrete pad for floor-mounted power conditioners/regulators . Refer to Division 26 Section, "Common Work Results for Electrical" for installation requirements.

3.2. GROUNDING

A. Separately Derived Systems: Comply with requirements of National Electrical Code Artic[illegible]250.3 – The grounding electrode conductor (GEC) connection shall be made at the source of the sepa[illegible]ely derived system (i.e. the transformer) in the power conditioner/regulator enclosure, w[illegible] the syst[illegible] bonding jumper shall also be installed. Provide supply-side bonding jumper from [illegible]nsform[illegible] first disconnecting means or overcurrent device after the transformer.

B. Comply with Division 26 Section "Grounding and Bonding" for [illegible]ls a[illegible] installation requirements.

C. Ground core and coil assembly to enclosure by means of a visible flexi[illegible] copp[illegible] grounding strap.

3.3. FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection:

1. Inspect for defects and physical [illegible]mage[illegible]ling, and compliance with requirements of drawings and schedules.
2. Clean transformers using Manufac[illegible]'s ap[illegible]ved methods and materials.
3. Verify that power conditioner/regulat[illegible]eplates are installed and accurate.
4. Verify that power cond[illegible]er/regulator phase identification nameplates are installed.
5. Verify that power c[illegible]ditio[illegible]r/regulator arc flash hazard labels are installed.
6. Check mounting [illegible]ea cle[illegible]es, and alignment and fit of components.
7. Check tightness o[illegible] electrical connections with calibrated torque wrench.
8. Refer to m[illegible]ture[illegible] instructions for proper torque values.
9. Verify t[illegible]t neut[illegible]ar is [illegible]nded to ground bar with appropriately sized bonding jumper.
10. Verify [illegible]at equipm[illegible]t ground bar is bonded to transformer enclosure. Securing ground bar to ven[illegible]pening is [illegible]t acceptable.

B. Trans[illegible]rmer E[illegible]ctrical Tests: Include the following minimum inspections and tests according to manu[illegible]tur[illegible]s written instructions to ensure transformer is operational within industry and manufa[illegible]er'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 power conditioner regulator 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 in test results.

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

C. Occupancy Adjustments: When requested within twelve (12) months of Substantial Completion, provide on-site assistance in readjusting transformer tap settings to suit actual occupied conditions. Provide up to two (2) visits to the project site for this purpose at no additional cost. Make voltage recordings at equipment/outlets selected by Owner, and record transformer secondary voltages for up to 48 hours.

END OF SECTION 263553

SECTION 263600 - TRANSFER SWITCHES

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 transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.

B. Related Requirements:

1. Division 21 Section, "Water Based Fire Suppression System – Fire Pump" for automatic transfer switches for fire pumps.
2. Division 26 Section, "Engine Generators" for engine generators serving transfer switches.

1.3. ACTION SUBMITTALS

A. Product Data: For each type of transfer switch indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Single-Line Diagram: Show connections between transfer switch, power sources, and load.

1.4. INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Field quality-control reports as specified herein.

1.5. CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section, "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6. QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Source Limitations: Obtain automatic transfer switches through one source from a sing manufacturer.

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

D. Comply with NEMA ICS 1.

E. Comply with NFPA 70.

F. Comply with NFPA 110, for transfer switches served by em ener

G. Comply with UL 1008 unless requirements of these Spec tions are tricter.

1.7. PROJECT CONDITIONS

A. Environmental Conditions: Transfer tch shall withstand the following environmental conditions without mechanical or electrical age or degradation of performance capability:

1. Ambient Temperature us 15 to plus 40 deg C.
2. Relative Humidity: to 95 ercent.
3. Altitude: Sea le to 10 (300 m).

1.8. COORDINATION

A. Coordinate size nd loca n of concrete bases for pad-mounted and floor-mounted transfer switche Cast and inserts into bases.

1.9. WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of transfer switches and associated auxiliary components that fail in materials or workmanship within specified warranty period.

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

MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

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

1. Caterpillar; Engine Div.
2. Emerson; ASCO Power Technologies, LP.
3. Generac Power Systems, Inc.
4. GE Zenith Controls.
5. Kohler Power Systems; Generator Division.
6. Onan/Cummins Power Generation; Industrial Business Group.
7. Russelectric, Inc.
8. Spectrum Detroit Diesel.

2.2. TRANSFER-SWITCH PRODUCT GENERAL REQUIREMENT

A. Indicated Current Ratings: Apply as defined in UL 08 fo ntin us loading and total system transfer, including tungsten filament lamp loads not ex ding ercent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withst Ra gs: A equate for duty imposed by protective devices at installation locations in Project un the fa conditions indicated, based on testing according to UL 1008.

1. Where transfer swi inc es internal fault-current protection, rating of switch and trip unit combinatio all ex indicated fault-current value at installation location.

C. Solid-State Control etiti ccuracy of all settings shall be plus or minus 2 percent or better over an operatin empe e ra e of minus 20 to plus 70 deg C.

D. Resistance to D age by V tage Transients: Components shall meet or exceed voltage-surge withstand ca bility ire ts when tested according to IEEE C62.41. Components shall meet or exce voltage mpulse withstand test of NEMA ICS 1.

E. Electric peration: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated m anism, mechanically and electrically interlocked in both directions.

Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

I. Battery Charger: For generator starting batteries.

1. Float type rated 10 A.
2. Ammeter to display charging current.
3. Fused ac inputs and dc outputs.

J. Annunciation, Control, and Programming Interface Components: Devices at transfer switches communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

K. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Electrical Identification."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
4. Use NEMA 250, Type 12 enclosure if environment is normally dusty.

L. Enclosures: General-purpose NEMA 250, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

1. Type 1 for dry interior locations.
2. Type 3R for damp or wet locations.

2.3. AUTOMATIC TRANSFER SWITCHES

A. Comply with NFPA 110 requirements for emergency power supply system level specified in Division 26 Section, "Engine Generators."

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of transfer to normal source. Interval is adjustable from 1 to 30 seconds.

E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

In-Phase Monitor for Open-Transition Transfer Switches: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

G. Programmed Switch Neutral Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

H. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Retransfer Delay Bypass: Momentary position to bypass retransfer time delay
6. Test Switch: Simulate normal-source failure.
7. Switch-Position Pilot Lights: Indicate source to which load is connected.
8. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

9. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
10. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
11. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

2.4. REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:

1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
2. Switch position.
3. Switch in test mode.
4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

1. Indicating Lights: Grouped for each transfer switch monitored.
2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.5. SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1. INSTALLATION

A. Wall-mounted Switches: Anchor to wall by bolting.

1. Design each fastener and support to carry load indicated by manufacturer. See Division 26 Section "Hangers and Supports."

B. Floor-Mounted Switches: Anchor to floor by bolting.

1. Concrete base 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless other-wise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports."

C. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

D. Identify components according to Division 26 Section 260553, "Identification for Electrical Systems".

E. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2. CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Division 26 Section 260526, "Grounding and Bonding for Electrical Systems".

C. Connect wiring according to Division 26 Section 260519, "Low-Voltage Electrical Power Conductors and Cables".

D. Connect transfer switch(es) to the fire alarm system as required to indicate the following signals:

1. Switch in non-automatic position.

E. Connect engine start monitoring modules in transfer switches to module in generator and to terminals in transfer switches per manufacturer's instructions. Refer to Division 26 Section 263213 "Engine Generators", for additional information.

3.3. FIELD QUALITY CONTROL

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

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

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.
4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source and each phase of alternate source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
    g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

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

F. Prepare test and inspection reports.

G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notations of deficiencies detected, remedial action taken, and observations after remedial action.

3.4. CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finishes to match original finish.

B. Clean equipment internally, on completion of installation, according to manufacturer's written instructions.

3.5. DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
2. Review data in maintenance manuals.
3. Review data in maintenance manuals.
4. Schedule training with Owner, through Architect, with at least seven days' advance notice.
5. Provide a minimum of four hours of instruction.

Coordinate this training with that for generator equipment specified in Division 26 Section, “Engine Generators”.

END OF SECTION 263600

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

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 260500, "Common Work Results for Electrical" for basic electrical installation requirements.

1.2. ALTERNATES

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

1.3. 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.

1.4. SYSTEM DESCRIPTION

A. Protect entire building including roof projections, chimneys, and roof-mounted equipment.

1. Building Construction: Steel building less than 75 feet (23m) in height.

2. Building Occupancy: Commercial.

B. Protect all ancillary buildings and structures on the main building property/campus, including, but not limited to, the following:

1. Metal Storage Building(s)

2. Greenhouse

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.

1.5. 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.

1.6. 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 the 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.

1.7. 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.

1.8. 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 24 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 24 inches above the object they protect.

C. Conductors:

1. Copper Cable Conductors (Class I):

a. Twenty-eight strand copper cable.
b. Minimum 230 lbs. / 1,000 Linear Feet (LF).
c. Minimum 6 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 [illegible] duty [illegible] inch length (minimum) with cast iron lid and frame.

H. Roof Penetrations: Through-roof assemblies with solid bars and appropriate roof [illegible]shing.

I. Miscellaneous Components: Provide other components requir[illegible] for a [illegible]mplete lightning protection system such as bonding plates, terminal supports, clips, [illegible]hors, fas[illegible]ers, bolts, nuts, screws, etc. All components shall conform to UL 96 for applicable cla[illegible].

1. Bonding plates shall not be less than 8 square i[illegible]hes of su[illegible]ce contact secured in place with stainless steel bolts.

J. Conduit: Provide 1-inch Type 40 PVC conduit for [illegible]down[illegible]ductors. Refer to Division 26 Section 260533, "Raceway and Boxes for Ele[illegible] Syste[illegible]" for product requirements.

K. Waterproof Penetrations: The Contrac[illegible] sh[illegible] prov[illegible]e all waterproofing for the through-roof conduits, connectors, and other penetrations.

PART 3 - EXECUTION

3.1. EXAMINATION

A. Verification of [illegible]onditions: [illegible]erify that field measurements, surfaces, substrates and conditions are as required [illegible]and [illegible]ady to re[illegible]ive work.

B. Exa[illegible]e surf[illegible]s and conditions, with Installer present, for compliance with installation tolerances and o[illegible] c[illegible]ditions affecting performance of the lightning protection system. Do not proceed with installat[illegible] 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. [illegible]ghtning 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 system conductors and down conductors.

E. Support conductors every three (3) feet.

F. Notify Engineer at least 48 hours before concealing lightning protection system components.

G. 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.

H. 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.

I. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to the Lightning Protection System.

J. Bond ground terminals with counterpoise conductor located below grade.

K. Bond grounded media on building within 12 feet (4 m) of ground with counterpoise conductor located as indicated.

L. Bond grounded media on building within 1 foot (4 m) of roof with counterpoise conductor.

M. Bond grounded media on building within 1 feet (4 m) of roof with interconnecting loop at eave level or above.

N. Bond lightning protection system to grounded media on building at every 60 feet (18 m) with intermediate-level interconnection conductors.

O. Install the conductors as continuously as practical and with the proper bends. Install conductors avoiding radius bends of less than 8 inches.

P. 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.

Q. 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.

R. 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.

S. 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 corners or more than 8'-0-inches apart.

7. Air terminals on standing seam metal roof systems shall be secured with stainless steel or aluminum 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 course to horizontal course.

5. All connections shall be electrically continuous.

6. Follow contour 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 [illegible]ntilato

B. Metal bodies of conductance shall be protected if not within the zone of p[illegible]ction [illegible]f the air terminals. All metal bodies having equal to, or greater than, 400 square inches s[illegible] be b[illegible]ded to the lightning protection system using main size conductors and a bondi[illegible] with [illegible] less than 3 square inches. Provisions shall be made to guard against corrosio[illegible]ue to je[illegible]ng o[illegible] dissimilar metals. Provide air terminals on metals that are less than 3/16th-i[illegible] thick, w[illegible]h are not in the cone of protection on roof areas, such as ventilators, air conditioning [illegible], etc[illegible]ll as required by the stated Code.

C. All major rooftop mechanical equipment and isolated[illegible]etal bod[illegible] within 6 feet of system conductors shall be bonded to lightning protections[illegible]stem [illegible]ain [illegible]f conductor with secondary conductors and appropriate bonding devices. Do not pe[illegible]rate [illegible]e housings for anchoring. Seal air and water tight all connections at mechani[illegible]uipme[illegible]

D. Interconnect conductive and inductive m[illegible]s as [illegible]quir[illegible] by the UL 96A Code.

3.7. GROUND CONNECTIONS

A. Use exothermic welding[illegible]e con[illegible]ons which form solid metal joints in the main vertical and horizontal conductors, and [illegible]nections that are not exposed in the finish work.

B. Provide ground [illegible]nectio[illegible]r ea[illegible] down conductor.

C. Metal wate[illegible] pi[illegible] and othe[illegible]arge underground metallic objects shall be bonded together with all groundi[illegible] mediu[illegible]

D. Grou[illegible]or[illegible]ections shall be protected from mechanical injury.

E. In making g[illegible]nd connections, utilize permanently moist areas as applicable.

[illegible] For the conductors located outside of the building, install the conductors not less than 2 feet (600 [illegible]m) below the finished grade.

Make connections of dissimilar metal with bi-metallic type fittings to prevent electrolytic action.

[illegible] 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 12 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. [ ] 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, the top of the building or stack, and at intermediate points with a sensitive ohmmeter. Compare resistance readings. Ground resistance shall not exceed 5 ohms. Submit test results.

END OF SECTION 264113

SECTION 265100 - 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, lamps, ballasts, emergency lighting units, and accessories.

B. Related Sections include the following:

1. Division 26 Section 260943, "Network Lighting Controls," for networked 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, weight, 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 samples submitted 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 requirement is noted.

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 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 indicating 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 be incorporated 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 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.

NEMA Compliance: Comply with applicable requirements of NEMA Standards Publication Numbers LE1 and LE2 pertaining to lighting equipment and LE4 pertaining to recessed luminaires.

J. 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 Ballast 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 20 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 20 of each type and rating installed. Furnish at least one of each type.
5. Globes and Guards: 1 for every 20 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, the products indicated in this Specification.

B. Data listed and model number shown, in this Specification 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 re-lamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during re-lamping 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.

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 aberration 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.
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. FIXTURES

A. Refer to “Interior Lighting Fixture Schedule” on the Contract Drawings.

2.4. 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.

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.
2. Metallic Finish: Corrosion resistant.

I. White finishes: Minimum of 85 percent reflectance.

2.5. FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section 260500, "Common Work Results for Electrical", and Division 26 Section 260529, "Hangers and Supports for Electrical Systems", for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (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 hang single fixture. Finish same as fixture.

D. Rod Hangers: 3/16-inch- (5-mm-) minimum diameter, cadmium-plated 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 shall not relieve the Contractor of responsibility of furnishing all necessary material, complete to perform function intended for indicated lighting system.

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. Osram Sylvania
3. Cooper
4. Philips
5. Samsung

B. Correlated color temperature (CCT): 3,500 Kelvin per ANSI C78.377, unless otherwise 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).

2.7. LED ELECTRONIC DRIVERS

A. Manufacturers: Provide quality LED electronic drivers by the manufacturers listed below. C 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 rces indi ted at full light output.
2. No PCBs.
3. Suitable for dry and damp locations.
4. Starting temperature: 0 degrees Celsi
5. 50,000 hour (minimum) design lif
6. Class 2 output UL recognized te L an CSA quirements.

C. Electrical Requirements:

1. 0-10V dimming sta ard, 5 minimum unless otherwise noted on the Contract Drawings.
2. Power Factor: 9 ercent 9) minimum.
3. Total Harmonic D n (THD): Less than 20 percent.
4. Sound Rati A
5. Short ci uit and erlo protection standard.
6. Inhere thermal p ection standard.

D. Listings

1. AN C62.41: Category A for transient protection.
2. NSI C82.11
3. Part 15: Non-consumer equipment EMC.
4. UL 1310: Standard for Class 2 Power Units.

E. Warranty:

1. Minimum five-year warranty.

MERGENCY 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

2.9. 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

2.10. 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 Illuminated Signs: As follows:

1. Lamps for AC Operation: Light-emitting diodes (LED), 25 + years rated lamp life.

2.11. PROTECTIVE WIRE GUARDS

A. Provide protective wire guards over lighting fixtures subject to physical damage. All lighting fixtures installed in the gymnasium, 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.

PART 3 - EXECUTION

3.1. INSTALLATION

A. Fixtures: Set level, plumb, and square with ceilings 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 systems 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. Pendant and Rod: 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 have 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 layout arrangement for the fixtures coordinates with the ceiling type and its suspension 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. In certain areas shown on the Drawings, the locations of fixtures are approximate only and the exact locations and pendant lengths shall be field coordinated with the Architect and/or Owner.

Q. 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.

R. 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.

S. Lighting fixtures for general illumination, emergency lighting, and exterior lighting, shall be complete with all required accessories and attachments.

T. Fixtures shall bear UL label and shall be wired and installed in full compliance with applicable codes.

U. 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.

V. Fixtures shall be recessed, surface, or pendant type, as specified and shall include lockets, diffusers, ceiling canopies and stems, hickeys, and all other necessary accessories.

W. 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. 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 equipment per NEC and manufacturer's instructions.

C. Exit signs and emergency lighting units shall be connected to the un-switched (hot) phase conductor of the lighting branch circuit serving the space, such that exit signs are illuminated at all times and emergency lighting units turn on upon loss of normal power. Switches, control panels, and relays controlling lights in the space shall not affect the operation of exit signs and emergency lighting units.

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 interior and exterior after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

C. Touch up luminaire finish at completion of work.

D. Replace lamps that fail within three (3) months of Substantial Completion.

E. Replacement Lamps: At the time of Substantial Completion, replace lamps in interior lighting fixtures which are observed to be noticeably dimmed or burned out after Contractor's use and testing. Furnish stock or replacement lamps as specified in this Section, Paragraph "Extra Materials". Deliver replacement stock as directed. Refer to Division 01 Sections for the replacement/restoration of lamps in interior lighting fixtures, and where used, the temporary lighting prior to time 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 265100

SECTION 26 55 01 - STAGE LIGHTING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Special Conditions, Division 1 Specification sections, and section 11 61 33 (Stage Rigging and Draperies) apply to work specified in this section.

1.2 RELATED WORK AND REQUIREMENTS

A. Section 26 00 00

1.3 SCOPE

A. This section requires the fabrication, furnishing, delivery, installation and testing of the lighting system as indicated on the drawings and specified herein.

B. The contractor shall provide all materials, equipment, labor, tools, and incidentals necessary to perform the scope of work.

C. It is the intention of these specifications that the contractor provides a professional quality, complete and properly operating system in every respect and detail.

D. The installation contractor shall examine the plans in detail to familiarize themselves with the scope of the work. Special attention shall be paid to review of all project electrical drawings, floor plans, conduit risers, and the like for locations and quantities of boxes and enclosures.

E. The contractor shall assume full responsibility for a complete operating installation, in the required location, in accordance with the contract documents.

F. Coordinate fully with the Division 26 Contractor.

G. Definitions: For this project, the following designations are referenced:

1. Owner: Dover Central School District, Dover
2. Architect: Becker Morgan Group, Dover, DE
3. Theatre Consultant: Scheu Consulting Services, Inc., Fayetteville, NY
4. The Contractor: The contractor or sub-contractor performing the work. The contractor shall be qualified per Part 1.6 of these specifications.

1.4 WORK INCLUDED

A. Without restricting volume or generality of above "Scope," work to be performed under this section shall include, but not be limited to, the furnishing and installation of the following:

1. Auditorium and Stage

a. A computer controlled dimming system with approximately 48 each "smart" breaker stage lighting relay circuits. The design shall incorporate a rear of house Tech Gallery position over the control booth, two balcony rail positions, four on stage lighting battens, four onstage plugging boxes, two apron face plugging boxes, and two concert ceilings. A certified stage lighting network with network receptacles that shall be located at each of the previously listed lighting positions. There shall be two LED follow spotlights. The stage lighting system consists of the relay panels and racks, auxiliary rack, network switch and patch bay, circuit distribution raceways, wire, DMX-512 computer-based stage lighting console, video display, console plug-in stations, a backstage control panel, a mix of LED, and moving stage lighting fixtures, cables, accessories and spares. The system infrastructure shall be network based.

b. A separate house lighting dimmer rack with up to12 relay circuits shall be included. House Lighting Control shall consist of a backstage control station, a portable touch screen control booth control station, a control booth entry station and entry stations located at the auditorium

exits.

c. An Emergency Lighting power and control transfer system

2. Black Box

a. A computer controlled dimming system with approximately 24 each "smart" breaker stage lighting relay circuits. The design shall incorporate plugging boxes mounted to the pipe grid and lower side walls, The stage lighting system consists of the relay panel, DMX splitter, circuit distribution plug boxes, wire, DMX-512, computer-based stage lighting control console plug-in stations, a wall mounted control station, a mix of LED stage lighting fixtures, cables, accessories and spares.

B. The Contractor shall examine the plans in detail to familiarize themselves with the scope of work.

C. The Contractor shall provide the required manufacturers' shop drawings.

D. The Contractor shall provide all the necessary specialty equipment for the complete lighting and dimming system installation as specified herein and as shown on the drawings.

E. The Contractor shall coordinate the system control wire conduit and device locations with the Division 26 Contractor.

F. The Contractor shall deliver to the job site, and coordinate the installation of, the specialty equipment with the Division 26 Contractor.

G. The Contractor shall provide, install, and terminate system control wires.

H. The Contractor shall provide and install all system control devices.

I. The Contractor shall uncrate, assemble, hang and aim all the stage lighting fixtures as shown on the drawings.

J. The Contractor shall provide for the system activation.

K. The Contractor shall provide the system manuals.

L. The Contractor shall provide the system warranty.

M. It is the Contractor's responsibility to ensure that the system and all of the system components, fixtures, equipment, devices, wire, terminations, field assemblies (including custom assemblies), etc. pass all required inspections by the local authority having jurisdiction.

N. Procurement of all required permits.

1.5 WORK NOT INCLUDED

A. The following work, although in another section, has a significant impact on the scope of this work. The Contractor is responsible for the successful coordination of the following:

1. System conduit.

2. Installation and termination of Line supply.

3. Installation and termination of Load wire.

4. Dimmer rack installation.

5. Non-dim panel installation.

6. Distribution installation.

1.6 CONTRACTOR'S QUALIFICATIONS:

A. Only qualified contractors shall be used.

B. The work of this section shall be contracted to a single firm, referred to as the contractor.

C. The contractor shall be a lighting system contractor who regularly engages in the furnishing, installation, and servicing of systems of similar nature, size, scope and complexity to that contemplated by this specification. The contractor shall have done so for a period of not less than five years preceding

the bid date.

D. The contractor shall have maintained for the five years preceding the bid date, a suitably staffed and equipped service organization which has continuously offered maintenance and repair services for systems of the nature, size, scope and complexity to that contemplated by this specification.

E. The contractor shall have on staff a factory trained field service agent, capable of system testing commissioning, and troubleshooting systems of the nature, size, scope and complexity to that contemplated by this specification.

F. The contractor shall have on staff a qualified and competent lighting designer / engineer capable of designing systems of the nature, size, scope and complexity to that contemplated by this specification.

G. The contractor shall maintain for the duration of this contract all required business and professional licenses and insurance.

H. The contractor shall demonstrate to the satisfaction of the owner, through submittals presented in accordance with the project timetable, that the contractor meets all the above qualifications. The minimum contractor qualification submittal shall include the following:

1. Statement of company history. Include a breakdown by percentage of gross dollar values of all business activities the contractor is involved in for each of the last 5 years (e.g. system installation = 30%, expendable sales = 40%, equipment rentals = 20%, design and other professional services = 10%, etc).

2. Previous experience: Furnish a list of four installations of a type and size contemplated by these specifications, currently in use as originally installed in which a theatre / system consultant was involved, completed in the last 5 years and the following information regarding each installations:

   a. Name and address of each installation facility.

   b. Facility owner and telephone number.

   c. Name, address, and phone number of a person regularly employed by the owner, who is familiar with the operation of the systems and who has no connection or business connections with the contractor except that the contractor shall fully disclose

   d. Name, address, and phone number of the theatre / system consultant, along with the names of all the consultant's personal directly involved.

   e. System shop drawings – These shall be returned if the contractor provides a call tag or return postage.

   f. Overall manual drawing – These shall be returned if the contractor provides a call tag or return postage.

   g. System as-built drawings drawing – These shall be returned if the contractor provides a call tag or return postage.

   List of contractors personal involved with each person's responsibility on the project.

   i. Name, address and phone number of the general contractor, along with the names of all key GC personal directly involved.

   j. Name address and phone number of the electrical contractor, along with the names of all key EC personal directly involved.

3. Statement of current company capabilities and ownership.

4. Key Personal: For each of the key personnel listed in the below; Include individual's name, title, and number of continuous years of service to contractor. Include a resume detailing industry experience, and role within organization (include only full-time/regular staff employees; not independent contractor, freelance, or temporary positions). List all industry certifications held, training courses attended, and continuing education credits, including dates of attendance.

   a. Project Manager

b. Senior Technician

c. Service Manager

5. Factory Trained Field Service Agent. Include individual's name and title. List all factory held certifications, training courses attended, and continuing education credits, including dates of attendance. Provide a list of recently commissioned systems, scope of project, and commissioning dates.

6. Lighting Designer / Engineer. Include individual's name and title. List current design credits with scope of project, and design completion dates.

7. Other Department Staff. Include size of staff and experience of each staff member.

8. Replacement and Spare Parts Inventory – Provide detailed list of primary replacement parts, components, and spares typically held in inventory.

9. Test Equipment and Physical Plant – Include an inventory of all test facility equipment owned and used regularly by the Service Department. Provide description of physical plant and space utilization.

10. Copies of all business and professional licenses and insurance certificates.

PART 2 - PRODUCTS

2.1 GENERAL

A. When this document lists several acceptable manufacturers for a particular item of equipment, more than one of which is to be provided, the Contractor shall furnish all of those similar items of equipment from one manufacturer.

B. All ETC and Strand dimmer racks, dimmer modules, lighting controls and lighting consoles shall be from the same manufacturer. Lightolier dimmers many only be used with Grand MA consoles and Pathport network distribution.

C. Any item of equipment or hardware that may not be specifically shown on the drawings or specified herein, but required for proper system operation or installation, shall be furnished and installed and be of the highest quality available.

D. All materials and equipment used in this project shall be new, unused and of the latest models and design. Refurbished materials and equipment are not permitted except where noted.

E. The performance of all equipment must meet the most recently published manufacture's data sheet.

F. UL Labels: All equipment, where applicable standards have been established, shall be listed by Underwriters' Laboratories, Inc., and shall bear UL label when delivered to the job.

G. If so required by the local authority having jurisdiction, anything not arriving at the job bearing a UL label shall be field inspected and labeled by a nationally recognized testing laboratory recognized and approved by the local authority having jurisdiction.

2.2 ACCEPTABLE MANUFACTURERS

A. The stage lighting and control manufacturer shall be one who has been continuously engaged in the manufacture of stage lighting control equipment, wiring devices, and electronic dimmers for ten years or more.

B. Except where otherwise noted in this specification, the following are the approved manufacturers for the listed respective products:

Altman Lighting Inc.
57 Alexander Street
Yonkers, NY 10701
(914) 476-7987

Electronic Theatre Controls, Inc.

3031 Pleasant View Rd
Middleton, WI 53562-0979
(800) 688-4116

LEX Products Corp.
401 Shippan Avenue
Stamford, CT 06902
(800) 643-4460

LynTec
8401 Melrose
Lenexa, KA 66214
(913) 529-2233

Lycian Stage Lighting
PO Box D
Kings Hwy
Sugar Loaf, NY 10981-0214
(845) 469-2285

Middle Atlantic Products, Inc.
North Corporate Drive
Riverdale, NJ 07457
(973) 839-1011

Pathway Connectivity
Acuity Brands Lighting
#103- 143917th Ave
Calgary AB T2G 1, Canada
403-243-8110

Robert J USA
48 Ca tal Dr.
Wall gford, CT 492
(203 94-0481

SSP
1 Freedom Court
reer, South Carolina 29650
(1) 848-9770

Strand Lighting, Inc.
267 5th Ave
New York, NY 10016
(212) 532-2593

Strong Entertainment Lighting
4350 McKinley Street
Omaha, NE 68112
(402) 453-4444

C. Substitutions: In no case shall equipment or materials of lesser design or workmanship be acceptable. Only those materials and equipment listed in this specification shall be considered unless prior approval is sought and received.

1. When a specific piece of equipment specified has been discontinued and/or replaced by a new model, substitution shall be acceptable when:

a. Submission of complete data on the new model or substitute has been approved by the owner prior to equipment acquisition.

b. Substitute equipment or the replacement of rejected equipment shall be at the no expense of the contractor.

2. Substitutes shall be considered only when they are submitted fourteen days prior to bid date and shall be accompanied by sufficient catalog data, specifications, and technical information for evaluation.

a. Summarize proposal with a list of equipment catalog or series numbers. Substitute bids shall include a system riser diagram detailing the components and any deviations of functionality from the drawings and specifications herein.

b. The bidder shall include the name, address, and phone number of at least two- (2) factory authorized Field Warranty centers within a 250-mile radius of the job site as a part of the submittal documents.

c. On the lighting fixtures, the bidder submitting other equipment shall include performance data taken and reported in compliance with the "Recommended Practice for Reporting Photometric Performance of Incandescent Filament Lighting Units used in Theatre and Television Production," approved as the official standard by the U.S. Institute for Theatre Technology, the Illuminating Engineering Society, the Society of Motion Picture and Television Engineers, and the American Theatre Association. For purposes of establishing the validity of such submissions, the manufacturer shall furnish this data from an independent testing laboratory. Proposals that fail to meet this requirement shall not be considered.

d. On the dimming system, the bidder submitting other equipment shall include pertinent performance data, reports and drawings showing in what respect the system will function in accordance with specifications and in what way it will deviate from the specification. This submittal shall include, but not be limited to the following:

i) Rated capacity, peak single cycle surge current rating, I^2t rating, and transient voltage surge rating of the output devices employed in the dimmers.

ii) Laboratory verification of minimum current rise time at a 90-degree conductive angle, with the dimmer operating at the maximum load.

iii) Description of the air-cooling and air filtration systems.

iv) Description of the packaging and ease of replacement for all spare parts required in this specification.

v) Original Manufacturer's catalog data sheets for all major components of the dimmer system.

e. For the control system, the bidder shall submit the name of the manufacturer, and list of ten (10) or more operating systems in the State of Delaware or surrounding area of the type specified which meet the performance control functions designed, with contact names and telephone numbers for references. This information shall be mandatory as a basis for determining the bidder's intent in meeting the full requirements of this specification and shall be submitted at least fourteen days in advance of bidding.

f. It is understood that any additions or revisions of wiring required by the use of substitute equipment, whether such wiring is part of this contract or of the prime electrical contract, shall be the responsibility of the bidder making the substitution.

g. If required by the Owner, the Consultant, or Architect, the bidder shall provide working

samples of substitute equipment including lamps for any lighting fixtures, to be delivered to the premises designated, for examination by Architects, Consultants, and such representatives as the Owner may direct. Handling, shipping and delivery to, or removal from site, of any sample required shall be at the cost of the Contractor. The Contractor shall be responsible for the arrangement of the cost of the electrical supply required to properly test any lighting instruments or item of equipment. Proposals which fail to address specification requirements or review comments shall be rejected.

h. Prior approval submittal review and approval shall not be considered to be shop drawing review. Prior approval in no way relieves the Contractor of responsibility to fully meet the requirements and intent of this specification.

i. Should the contractor propose and receive approval for the use of alternate or substitute equipment which requires additional or modified conduit, the contractor shall be solely responsible for the installation of such conduit.

2.3 AUDITORIUM STAGE AND BLACK BOX LIGHTING RELAY RACKS

A. General

1. Intelligent breaker system shall be 120V Sensor IQ systems as manufactured by ETC, Inc., or equal
2. Breaker Panels shall be UL508, UL67, and UL924 Listed, and shall be so labeled when delivered
3. Breakers shall be UL489 listed and shall be labeled when delivered
4. Breaker Panels shall consist of a main enclosure and 12, 18 or 24 pole breaker subpanels, integral control electronics for low voltage terminations and provision for accessory cards
   a) Up to two accessory cards shall be supported per breaker panel

B. Mechanical

1. The panel shall be constructed of 20 gauge galvannealed steel. All panel components shall be properly treated or finished with fine-textured, scratch resistant paint
2. Breaker panels shall be capable of being mounted on the surface of a wall or recessed mounted
3. The breaker panel for the Auditorium shall be a 48-pole configuration. The breaker panel for the Black Box shall be a 24 pole configuration
4. Panel cover shall be for surface mount application. This outer panel shall ship complete with a lockable door to limit access to electronics and breakers
5. The unit shall provide interior cover over the control electronics and accessory cards to allow access only to class 2 wiring and prevent direct access to class 1 line voltage components
6. The panel for the Auditorium system shall support up to 48 single pole branch circuits The panel for the Black Box system shall support up to 24 single pole branch circuits
   a) Branch circuits shall range from 15A to 30A capable of holding full rated load for minimum of three hours continuously
   b) Two and three-pole circuits shall be supported at decreased density where each pole constitutes one of the available single-pole circuits. Mixing of circuits in any combination shall be supported
7. Breakers shall provide manual switching control while power is unavailable to the panel such that critical lighting can be set to an on state, without the need for power to the panel
8. Breaker output lugs shall accept 10-14 AWG dual conductor wire
9. Breaker output lug shall support solid or stranded 6-14 AWG class B, C, or K copper wire
10. Control wiring for DMX, station bus, and Emergency input terminations shall land on a removable leader for contractor installation

C. User Interface

1. The user interface shall contain an LCD display with button pad to include 0-9 number entry, up, down back arrow navigation and enter
2. Test shortcut button shall be available for local activation of preset, sequence and set level overrides
3. The user interface shall have a power status LED indicator (Blue), a DMX status LED indicator (Green), a network status LED indicator (Green) and an LED indicator (red) for errors
4. Interface shall allow the backlight to timeout and shall provide user editable options for the backlight completely as well as adjust screen contrast
5. Ethernet interface shall default to automatic IP through link local and DHCP. Upon receiving IP address, the address of the Network Interface Card (NIC) shall display in the about menu. Static address and settings shall also be possible
6. The control interface shall support a USB memory stick interface for uploads of configurations and software updates
7. The user interface shall support power input from an external Uninterruptable Power Supply (UPS) supplying 800W-2400W AC power

D. Functional

1. Panel setup shall be user programmable. The control interface shall provide the following breaker setup features (per circuit):
   a. Type (1 pole, 2 pole, or 3 pole)
   b. Name
   c. Circuit Number
   d. DMX address
   e. sACN address
   f. Space Number
   g. Circuit Modes
      1) Normal (priority and HTP based activation and dimming)
      2) Latch/Lock
      3) Fluorescent
      4) DALI
   h. On threshold level
      Off threshold level
   j. Include in UL924 emergency activation
   k. Allow Manual
2. Breaker panels shall support discrete addressing of each breaker. Panels that are restricted to use of start address with sequential addressing, and cannot assign each 0-10V output control to any internal circuit shall not be acceptable
3. The panel shall be capable of switching 6 poles on or off at once, or in a user-selectable delay per breaker using a period of 0.1 to 60 seconds, in 0.1 second increments
4. An Ethernet connection shall provide advanced control of relays over streaming ACN (sACN) and transmit status, control override, and measured energy usage per branch circuit via an internal Web UI or central monitoring interface
   a. Control electronics shall report the following information per branch circuit.

1) Breaker state (On/Off)

2) Breaker state (Open/Closed)

3) Current draw (In Amps)

4) Voltage

5) Energy usage

b. Panels that do not report this information shall not be acceptable.

5. Built-in Control shall include:

a. Ability to record up to 16 presets in each space from the control panel, connected control stations, or timed events

b. Presets shall be programmable by recording current levels (as set by DMX or connected control stations), by entering levels on the control panel directly, manually selecting breaker state on each breaker, or a combination of these methods. From the control panel, stations, or timed events it shall be possible to record values for up to 16 zones per space

c. Up to 8 spaces in a single rack for total of up to 16 spaces shall be supported per system or system subnet

d. Indication of an active preset shall be visible on the control panel display

e. One 16-step sequence per space for power-up and power-down routines

f. The panel shall have a UL924-listed contact input for use in Emergency Lighting systems. The panel shall respond to the contact input by setting included breakers to "on", while setting non-emergency breakers "off". Each breaker shall be selected for activation upon contact input

g. Upon Data loss the system shall provide options to hold last look infinitely or hold for a configured time period set by the installing technician then fade/switch to the input of the next available priority

h. Control electronics shall respond directly to control stations for zone, preset, and sequence control. Systems that require secondary control systems for this functionality are not acceptable

i. After power loss, electronics shall be capable of holding the system in its previous state until new level data (DMX, architectural presets, sequences and zones, or local overrides) is received to make each breaker change state

6. The control of lighting and associated systems via timed and Astronomical clock controls

a. The breaker panel shall allow the activation of presets, sequence, and zone programming of up to 50 time clock events via a built in real and astronomical time clock

System time events shall be programmable via the control panel

1) Time clock events shall be assigned to system day types. Standard day types include: everyday, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday

2) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event

3) System shall automatically compensate for regions using a fully configurable daylight saving time

4) Presets shall be assigned to events at the time clock

c. The time clock shall support event override. It shall be possible to override the timed event schedule form the face panel of the time clock

d. The time clock shall support timed event hold. It shall be possible to hold a timed event from

the face panel of the processor. Timed event hold shall meet California Title 24 requirements

7. The panel shall receive ESTA DMX512-A control protocol. Addressing shall be set via the user interface button keypad with any circuit patched to any DMX control address
   a. 2,500V of optical isolation shall be provided between the DMX512 inputs and the control electronics as well as between control and power components
   b. The breakers shall respond to control changes (DMX or Stations) in less than 25 milliseconds. DMX512 update speed shall be 40Hz
   c. Setting changes shall be able to be made across all, some, or just one selected circuit in a single action from the face panel
   d. DMX data loss shall allow for levels/breakers to be held for ever or for a specified time before switching to a lower priority source
   e. Initial Panel setup
      1) The breaker panel shall automatically detect the type of breaker or dimmer installed in each location without need for manual configuration of physical arrangement
      2) Quick rack setup shall be available to apply address settings across all circuits for rack number, DMX Start Address, sACN universe, and sACN start address
      3) Emergency Setup Menu shall provide option for delay when emergency is activated or deactivated, and option to turn off non-emergency circuits shall be available. Record function shall allow circuits that are turned on to be added to the emergency setting

E. Electrical
   1. Breaker Panels shall be available to support power input from:
      a. 120/208V three phase 4-wire plus ground
      b. 120/240V single phase 3-wire plus ground
   2. Conduit Entry:
      a. Feeders:
         1) Top or upper 6” of either side
         2) Bottom or lower 6” of either side

         Feeders shall enter through the top or bottom according to the orientation of the enclosure.

         4) Feeder entry shall be nearest to the location of the feeder lugs or main breaker.
      b. Load:
         1) Load wiring shall enter through the top or bottom of the enclosure through the surface nearest to the breaker sub panel
         2) Load wiring may also enter through left and/or right side provided a low voltage chase is not required through the same area. If class 2 chase is required, a field installable barrier panel shall be provided upon request. The side of the panel where the barrier has been installed shall not permit load wiring
      c. Low Voltage:
         1) Top or upper 6” of either side
         2) Bottom or lower 6” of either side
         3) For low voltage conduit entry at the breaker end of the cabinet, conduits shall be located at the outer 3” of the top/bottom panel
   3. Breaker

a. Bus connection type: Stab on
b. 1, 2, or three poles
c. UL489 listed
d. 15 amp, 20 amp, or 30 amp
e. 22,000 SCCR; 65,000A series rated with main breaker
f. High inrush trip curve (matches all Sensor breakers)
g. Maintains trip curve through entire thermal range
h. Guaranteed not to trip at full load
i. Load lugs accept 6-14awg load wiring
j. Multi-conductor listed output terminal
k. Integral mechanically held air gap relay
l. Manual control of relay state using breaker handle w/o
m. Integral current sensing
n. Integral position and trip sensing
o. Control and status provided by contact pad directly
bottom of the breaker case
p. No external wires or connections required for
feedback
q. The breaker shall be capable of switch
to 30

4. The breaker panel shall support a maximum fe
of 400 Amps at 48 circuits and 200 Amps at 24 circuits.
a. Breaker panels shall s
port m
n circuit breaker options:
b. Main breaker options s
optional and available for purchase upon request
c. Main breaker
field
tallable
d. Main brea
s shall be
ailable in up to 100 Amps for 12 circuit panels, up to 200 Amps for 24 circuit p
els, and u
to 400A for 48 circuit panels at 120V
e. S
es SCCR r
apply as follows with appropriate main breaker: 22,000A or 64,000 at
0/208
g. Ma
reakers shall allow the following range of wire sizes:
1) Up
300kcmil at 100A and 200A
2) Up to 2x250kcmil at 400A
Main Lug input shall support up to 2x250kcmil
i. Breaker panel shall support a 500kcmil main lug option for 48-circuit panels

F
Breaker remote switching ratings
1. Mechanical 1,000,000 cycles
2. 24A Resistive 100,000 cycles
3. 16A Ballast (HID) 75,000 cycles
4. 15A Electronic (LED) 100,000 cycles
5. 15A Tungsten 45,000 cycles
6. 30FLA; 180 LRA Motor Load 50,000 cycles
7. Tested duty cycle: 12 operations (6 cycles) per minute

8. Decreasing duty cycle significantly increases switch life
9. Isolation: 4000V RMS
10. Current reporting accuracy: 5%
11. Latching state mechanical relay

G. Breaker Panel Accessories

1. A low voltage 0-10V dimming option shall provide up to 24 0-10v control outputs that are li[illegible]d to relay circuits within the panel. Each output shall support up to 400mA of current si[illegible]er outpu
2. A contact input option shall provide 24 dry contact inputs to be linked for dire[illegible]t or g[illegible]up relay control, to activate a preset, or to activate a sequence. Controller software shall a[illegible] for n[illegible]ally open maintained, normally closed maintained, or momentary toggle
3. A DALI control option shall provide 24 control loops of broadcast D[illegible]li contr[illegible]with [illegible]ch loop controlling up to 64 DALI devices
4. A RideThru option shall provide short-term power backup of co[illegible]l elec[illegible]nic[illegible]y automatically engaging when power is lost, and recharging when normal [illegible]wer is [illegible]esen
5. An Isolated Ground option shall provide each circuit in [illegible]panel wi[illegible]a ground terminal that is electrically isolated from the equipment ground
6. Main Breaker options shall be available as shown in Se[illegible]n E.4

H. Thermal

1. The panel shall be convection cooled. P[illegible]s [illegible]at re[illegible]re the use of cooling fans shall not be acceptable
2. The panel shall operate safely i[illegible] environmen[illegible]having an ambient temperature between 32ºF (0ºC) and 104ºF (40□C), and [illegible]umi[illegible]y between 5-95% (non-condensing).

2.4 AUDITOTIUM HOUSE LIGHTI[illegible]RAC

A. The basis of design for th[illegible]house [illegible]hting rack enclosure shall be the Unison DRd Series Control Enclosure as manufa[illegible]red b[illegible]ectre[illegible] Theatre Controls, Inc., or approved equal.

B. Mechanical

1. The Rac[illegible]Enclos[illegible]shall[illegible]e a surface mounted, deadfront switchboard, constructed of 18-guage form[illegible]steel p[illegible]els wi[illegible]h a hinged, lockable full-height door containing an integral electrostatic air f[illegible]
   a. Filte[illegible]all be removable for easy cleaning.
   b. The enclosure shall support one control processor and one station power module plus accessories
   The enclosure door shall have an opening to allow limited access to the control module face panel.
2. All rack components shall be properly treated and finished.
   a. Exterior surfaces shall be finished in fine textured, scratch-resistant, epoxy paint.
3. The fully digital rack enclosure shall be available with six or twelve dimmer module spaces, one processor and a single station power supply, Rack dimensions and weights (without modules) shall not exceed:
   a. DRd6 21.9” H x 17” W x 9.6” D 38 lb.
4. A single low-noise fan shall be located at the top of each rack. The fan shall draw all intake air through the integral electrostatic air filter, over the surfaces of the module housing and out the top of the rack.
   a. The fan shall maintain the temperature of all components at proper operating levels with

dimmers under full load, provided the ambient temperature of the dimmer room does not exceed 40°C/104°F.

b. In the event of an over-temperature condition, only the affected dimmer module(s) shall shut down. A red indicator LED will flash and an error message shall appear on the Control Processor.

5. Rack Enclosures shall be designed to allow easy insertion and removal of dimmer and control modules without the use of tools. (230 volt racks with CE certification shall require a screwdriver.)

a) Supports shall be provided for precise alignment of modules into power and signal connector blocks.

b) With modules removed, racks shall provide clear front access to all load, neutral and control wire terminations.

6. Rack Enclosures shall support use of any combination of rack option cards designed to provide additional rack features. Rack option cards shall include:

a) FLO - The Fluorescent Option Board shall provide termination for 24 fixture low voltage electronic fluorescent dimming ballasts. FLO shall provide 24, 0-10V DC outputs.

b) DALI - The DALI Option Board shall provide termination for DALI fluorescent dimming ballasts. DRd shall provide 24, DALI outputs for up to 64 ballasts each in a broadcast mode.

7. Optional floor mounting pedestal shall be available for a 12-module rack.

8. Racks enclosures shall be designed for use with AX series auxiliary racks for Main Circuit Breaker, Main Lug, and cross bussing applications.

C. Electrical

1. Rack enclosures shall be available in 100, 120, 230, 240 and 277 volt, three-phase, main lug configurations.

a) 120 volt rack enclosures shall be configurable for single phase operation without the need for additional components

2. Rack enclosures shall be completely pre-wired by the manufacturer. The contractor shall provide input feed, load and control wiring.

3. Standard Short Circuit Current Ratings (SCCR) shall be 22,000 at 100-277 Volt

a) Higher SCCR ratings, up to 100,000 amps SCCR at 120V, shall be possible when used with an AX series Auxiliary Rack Enclosure.

b) Higher SCCR ratings, up to 65,000 amps SCCR at 240V and 277V, shall be possible when used with an AX series Auxiliary Rack Enclosure.

All control wire connections shall be terminated via factory provided connectors.

5. Rack enclosures shall support dimming for incandescent, fluorescent, neon, cold cathode, electronic low voltage and magnetic low voltage transformer load types.

6. The rack enclosure shall support 16-bit DMX input

7. The rack enclosure shall support 65,000 steps of dimming.

8. The rack enclosure dimming engine shall support multiple dimmer curves including modified square law, linear, switched, fluorescent, pre-heat and electronic low voltage.

9. The rack enclosure shall support voltage regulation including, minimum and maximum scale voltages with offsets

10. Rack enclosure shall support a UL924 listed contact input for emergency lighting control bypass.

a) Emergency lighting input shall support load shedding

11. Rack enclosures shall be designed to support the following wire terminations:

a) AC
b) Echelon link power (Belden 8471 or equivalent)
c) 24Vdc (2- 16AWG Wire)
d) DMX512A Port A (In or Out) (Belden 9729 or equivalent)
e) DMX512A Port B (Out) (Belden 9729 or equivalent)
f) RS232 Serial In/Out (Belden 9729 or equivalent)
g) Unshielded Twisted Pair (UTP) Category 5/5e Ethernet
h) Contact Closure In (14AWG to 26AWG Wire)
i) Contact Closure Out (14AWG to 26AWG Wire)
    i) Contact Closure Out shall provide 1A @ 30vDC

12. Station Power Modules
    a) Station power modules shall provide power for the con ntro Options shall be available for use with Paradigm, Echo and SmartLink ontrol pr cols
    b) Station power modules shall support over-curren /sho otectio
    c) Station Power Modules shall support fault detectio or the bus.
13. All control wire connections shall be termin d v factory ovided connectors.
14. Main feed lugs shall accept a maximum 50 M CM v e.
15. Load terminals shall accept a maximum of # WG re.

D. Thermal
    1. Ambient room temperatur -40°C 32-104°F
    2. Ambient humidity: 10-90% ondensing

2.5 HOUSE LIGHTING POW ULE

A. The house lighting wer modu shall be of modular design for easy installation and removal. Each module to com eq ped with o 2.4kw dimmers, or relays, or constant current (as required) with magnetic ci it brea an sealed power device assembly. The sealed power device assembly must be fi d repli le without soldering.

B. Furnish th ules from one of the following approved manufacturers; see system one line for quantities.

1. Electronic Theatre Controls, Inc.

CAT. #	DESCRIPTION
R20	House lighting relay modules. Dual 20 amp modules for house lighting relay circuits
R20	One spare
CC20	Constant current modules. Dual 20 amp modules for normal sense feed to emergency lighting system
AFM	Furnish necessary quantities of Air flow modules

2. Strand Lighting Inc.

CAT. #	DESCRIPTION

	House lighting 2400w relays for house light relay circuits as required for Contact Relay Panel
	House lighting 2400w relays for normal sense feed to emergency lighting system as required for Contact Relay Panel

2.6 AUDITORIUM LIGHTING MAIN LIGHTING CONSOLE

A. Furnish the quantity of main lighting control consoles and accessories from one of the following approved manufacturers.

1. Electronic Theatre Controls, Inc.

QTY.	CAT. #	DESCRIPTION
1	Ion Xe 20 – 12K	Ion lighting console with 20,288 output configuration. Include office editor software
2	-	Minimum 19” LCD DVI Touch Screen Monitors
1	-	10’ Network cable (console)
1	-	10’ DMX cable
1	-	10’ Network cable (portable node)
1	ETCPad	For Remote Focus Unit
1	-	Console dust cover
2	-	Monitor dust cover
1	-	Controller mini keyboard
1	-	Controller mouse
1	2 kVA UPS	Uninterrupted Power Source.
2	Littlite	Task lights
1	-	6’ extension cable
1	-	6 receptacle power strip

2. Strand Lighting, Inc.

QTY.	CAT.	DESCRIPTION
	91001	NEO Lighting Control Console w/ 1 universe of DMX
2	91002	1 each additional universe of DMX
2	91021	19” LCD DVI Touch Screen Monitors
1	65100	NODE-2 - SN 100 Network Node – portable
1	-	10’ Network cable (portable node)
1	-	10’ Network cable (console)
1	-	10’ DMX cable
1	-	10’ Console sub master interface cable.
1	iPad Mini with Otterbox case	For Remote Focus Unit
1	$100 i-Pad software gift card	For i-Pad lighting software, install so owner is account holder
1	66305	Ethernet Card
1	-	console dust cover
1	-	19” monitor dust cover
1	2 kVA UPS	Uninterrupted Power Source
1	-	Controller mini keyboard
1	-	Controller mouse
2	Littlite	Task lights

2	-	6’ extension cable
2	-	6 receptacle power strip

2.7 BLACK BOX CONTROL CONSOLE

A. Furnish the quantity of main lighting control consoles and accessories from one of the followin approved manufacturers:

1. Electronic Theatre Controls, Inc.

QTY.	CAT. #	DESCRIPTION
1	CS20AV	20 Fader ColorSource AV console aud and video features (80 Channels/Devic
1	-	10’ DMX cable
1	I1866	Pelican Case with foam fo CS20AV nsole
1	CS40DC	Console Dust Cover
1	2 kVA UPS	Uninterrupted Power Source
2	Littlite	Task lights
1	-	10’ extension ble
1	-	6 receptacle po strip

2. Strand Lighting

QTY.	CAT. #	ESCR ON
1	64341	0 us se s 24/48, console
1	95220	1 CD I I Touch Screen Monitors
1	95090	10’ I cable
1	95220	20” flat panel monitor
1	-	Pelican Case with foam for 200 Plus console
2	-	20” monitor dust cover
1	2 kVA UPS	Uninterrupted Power Source.
2	L	Task lights
1		610 extension cable
1		6 receptacle power strip

2.8 COMPUTER

A. Furnish a Laptop computer (or equal) which meets all minimum requirements for the auditorium’s c ole offline software package. Include console offline software package installed on aptop computer.

2.9 LIGHTING CONTROL CONNECTION PLATES

A. The stems shall be accessible via interconnection plates for the lighting control console and Ethernet or DMX output receptacles located at the performance lighting positions. Furnish lighting plugging stations; see contract drawings for type, quantities and locations.

2.10 DITORIUM HOUSE LIGHTING MAIN CONTROL

A. General Description

1. Control shall be low-voltage type as specified here and as listed below and/or shown on the drawings. Controls shall use low-voltage Class II electrical wiring. All controls shall be able to access and control house light dimmers.

2. Furnish and install the following equipment and accessories; see system one line for quantities and the device location drawing for placement.

a. Electronic Theatre Controls, Inc.

CAT. #	DESCRIPTION
PI1004	Inspire 4 Button Control Station. Station color per architect.
P-TS7-P	7 in Portable Touchscreen (Link Connect) Pendant style Master control station

3. Electronic Theatre Controls is the basis for design. Other aacceptable manufacturers are Strand Lighting and Lightolier Controls, Inc.

2.11 AUXILARY STAGE AND HOUSE LIGHTING CONTROL (ALCS)

A. General description: Control shall be touchscreen type as specified here and as listed below and/or shown on the drawings. Control shall be via low-voltage Class II electrical wiring. All controls shall be able to access and control production and house light dimmers.

B. The control station is to act as a small event controller that can capture stage and house lighting presets that consist of conventional and LED lighting fixtures and play them back from the backstage control panel (BSCP). Operate default or custom system functions including preset selection, manual mode activation, record mode activation, station lockout, raise, lower, [illegible] control zone on/off, macro activation and timed event override. Virtual fader functions include master, zone, fade rate, or preset. Custom button and fader functionality programmable via configuration software. Programmable electronic lockout levels. Buttons allow programming of individual lockout levels.

C. The BSCP rack shall be furnished by the auditorium Audio and Video contractor. See AV drawings for additional information. Coordinate all space, wiring and power requirements with Auditorium AV contractor.

D. Furnish and install the following equipment and accessories.

1. Electronic Theatre Controls, Inc.

QTY.	CAT. #	DESCRIPTION
1 for Auditorium	P-[illegible]4	Paradigm 7" Touchscreen - Black
1 for Auditorium	P-TS[illegible]4	Paradigm 7" Touchscreen Rack Mount Kit
The items below are to be provided separate from the BSCP		
1 for Black Box	P-[illegible]7-_	Paradigm 7" Touchscreen – Color by Architect
1 for Black Box	P-LCD-FBB	7" Touchscreen Flush Back Box
1 for Black Box	P-LCD-LC-_	7" Touchscreen Hinged Locking Cover – Color by Architect

2. Electronic Theatre Controls is the basis for design, acceptable manufacturers are Strand Lighting and Lightolier Controls, Inc.

2.12 EMERGENCY DMX BYPASS KITS

General Description

1. Where required to trigger special-purpose lighting presets and bypass normal lighting controls during emergency or panic situations, the bypass means shall be the DMX Emergency Bypass Controller (DEBC). Electronic Theatre Controls is the basis for design alternative manufacturers are Strand Lighting Inc. or an approved equal.

2. Furnish and install the following equipment and accessories; see system one line for quantities and the device location drawing for placement.

B. Functional

1. The DMX Emergency Bypass Controller shall be capable of overriding a single universe of ANSI E1.11–2008, USITT DMX512-A control signals from "Normal" to "Bypass" when a trigger signal is detected via a two-pin trigger input.

2. The DMX Emergency Bypass Controller shall be capable of recording a single DMX preset (snapshot) of 512 channels for recall during "Bypass" mode.

C. The DMX Emergency Bypass Controller (DEBC) enclosure shall be a surface mounted enclosure constructed of 16-gauge, formed steel panels with a removable front cover.

1. Dimensions 9"H x 11"W x 2"D.

2. Enclosure located in dimmer room.

D. The DMX Emergency Bypass Controller (DEBC) shall support one Universe (512 channels) of Digital Multiplexing (DMX) in accordance with ANSI E1.11–2008, USITT DMX512-A.

1. Controllers that do not support E1.11–2008 compliant DMX communications shall not be acceptable.

2. The DMX Emergency Bypass Controller (DEBC) shall not process (pass-through) the normal DMX input

3. The DMX Emergency Bypass Controller (DEBC) shall internally switch from the normal DMX input (pass through) to the bypass DMX output using electro-mechanical relays when triggered.

2.13 EMERGENCY BYPASS DETECTION

A. General Description

1. The emergency bypass detection kit monitors a normal power feed in single and three phase systems and generates a maintained contact closure upon loss of power to trigger the UL924 listed emergency bypass operation.

2. Electronic Theatre Controls is the basis for design alternative manufacturers are Strand Lighting Inc. or an approved equal.

3. Furnish and install the following equipment and accessories; see system one line for quantities and the device location drawing for placement.

B. The Enclosure shall be a surface mounted, constructed of 16-guage formed steel panels removable front cover finished in fine texture scratch-resistant, powder coat paint.

1. Dimensions are 9.5" H x 7"W x 4.2"D.

2. Enclosure located in dimmer room.

C. Emergency Bypass Detection enclosures shall support 100 to 277 volt configurations.

D. EBDK enclosure shall be field configurable for single-phase, bi-phase, and three-phase operation without the need for additional components.

E. The Emergency Bypass Detection Kit shall be completely pre-wired by the manufacturer. The contractor shall provide input feed and control wiring.

F. All control wire connections shall be terminated via factory provided connectors.

G. The Bypass Detection Kit shall be UL and cUL Section 924 Listed for interaction with similarly listed dimming and switching panels.

2.14 EMERGENCY LIGHTING TRANSFER SWITCH

A. General

1. The Emergency Lighting Transfer Switch (ELTS) shall provide automatic transfer of branch circuits from normal to emergency power when normal power fails. Electronic Theatre Controls is the basis for design alternative manufacturers are Strand Lighting Inc. or an approved equal.

2. The ELTP shall transfer designated lighting load branch circuits from normal relays or secondary control outputs to a second power source in the event of a loss of power to the dimmer rack, a normal system failure, or activation of fire alarm.

3. The system shall comply with ANSI / UL1008 Transfer Switch Equipment, ANSI / NFPA 110 Standard for Emergency and Standby Power Systems, and ANSI / NFPA 70 (NEC), including

Article 700, 701 and 702 safety standards. Emergency transfer systems that do not comply with the below stated NEC articles and sections shall not be permitted

4. The ELTS shall be a self-contained system for up to 24 circuits at 20 amps. The unit shall be available with either discrete emergency branch circuit feeds from an external circuit breaker panel or a single main feed (by others)

B. Transfer Switch

1. The switch shall be a UL 1008 LISTED, electrically operated, and mechanically held (maintained) transfer switch.
2. The switch shall be positively locked and unaffected by voltage variations or momentary outages so constant contact pressure is maintained and temperature rise at the contacts is minimized.
3. The switch shall be mechanically interlocked to ensure only one of the possible positions, either Normal or Emergency.
4. Each switch shall be configured as guaranteed break-before-make
5. Built-in fuses shall provide up to 65000A Short Circuit Current Rating (SCCR) on connected emergency circuits.
6. Built-in fuses class G shall be provided on each output for appliance with NEC Section 700.27 Coordination – larger upstream breakers cannot be tripped by downstream branch circuit faults.
7. Switch contacts shall withstand transfer without welding, with 180º phase displacement between Normal and Emergency power sources, both sources energized and with 80% load.
8. Transfer switch contacts shall be rated for mixed load including electric discharge lamps and tungsten filament lamps.
9. Transfer switches shall be rated for 6000 cycles at full tungsten load.

C. Control Circuit

1. The control circuitry shall control the operation of the transfer switch.
2. User configurable time delays shall be provided for power transfer between:
3. Loss of normal power and the transfer to emergency up to 10 seconds.
4. Restoration of normal power and the transfer from emergency back to normal power up to 60 seconds.
5. A normally closed dry contact closure fire alarm input shall be provided.
6. Transfer switch shall support connections for up to 5 Remote Stations which can manually switch between normal and emergency power.

D. Operation

1. Transfer to alternate supply will occur when normal supply voltage drops below 80V when used at 120V,
2. A self-supervising isolated signal input shall be provided for connection to the facility fire alarm. The ELTP shall automatically transfer the loads to the Emergency power source when the facility fire alarm is activated as part of a normally-closed loop.
3. A key-operated switch shall be provided to manually control the ELTP. All automatic functions shall override this control. Two indicator lights shall be provided to show the position of the transfer switch.
4. All automatic functions shall override remote control functions. Any combination of open or shorted wiring to remote stations shall not affect automatic functions, or disable the local switch.

2.15 AUDITORIUM DMX DISTRIBUTION AND ETHERNET WIRING

A. Furnish equipment as shown on system drawing.

B. Install a certified CAT 6e network for this venue.

1. All branches shall be fully tested and documented using a Certified CAT 6e tester.

2. All Components (wire, connectors, inline couplers, patch bay, patch cords, etc.) shall be fully CAT 6e compliant.

C. Install the following hardware (when quantities above those shown on the system drawing are calle for, those extras shall be furnished as loose equipment) for each venue.

1. DMX/RDM rack mount Four port Gateways configured as input node

a. ETC N34G-4M

b. ETC is the basis for design, acceptable manufacturers are Strand Lighting a Pathp

2. DMX/RDM rack mount Four port Gateway configured as output node

a. ETC N34G-4F

b. ETC is the basis for design, acceptable manufacturers are Strand L ting a Pathport.

3. HUB-1 36 port minimum managed gigabit network switch th Po PoE p wer to be sufficient to support all devices that are connected.

a. 3Com or similar

4. PBY-1 Network Patchbay. 36 port RJ45. Provide requ d num er of modular outlets. Include labeling.

a. Siemon HD5-series or similar

5. Wireless Access Point (WAP) with single po Setu

a. Cisco WAP 121 Wireless-N cess point or qual.

6. One(1) DMX Opto-Splitte r hou lighting fixture control.

a. Pathway DMX Repeat r or equal.

7. Uninterrupted Po ly - k mount

a. APC Sma UPS RT22 VA RM 120V uninterrupted power supply 120v input/120v output, extended r time mod with switched outlet groups to connect critical equipment to a swi ed out roup onfigured to turn on immediately in the event of a power outage and t connect peripheral equipment to a group configured to shut down, after a short period, in eve of a power outage in order to conserve battery run time (or Equal)

b. AP mart UPS 120v external Battery pack (or equal).

8. Thirty (30) 3 CAT 6e patch cords

a. Black Box EVSA85-000 or similar.

9. work Gateways

a. ETC single port gateway tour is the basis of design; alternative manufacturers are Strand Lighting and Pathport

10. One wall mount equipment rack in each space for Auxiliary Rack 1. Furnish swing open access wall mount auxiliary rack as indicated on drawing. Furnish rack back box to electrical contractor and coordinate instillation. Provide internal power . Fill all unused rack spaces with blank panels.

a. AR-1: Middle Atlantic Products DWR-24-32 with FD-24 front door.

b. Furnish and install the following equipment in the AR-1 rack see contract drawings for location:

QTY.	DESCRIPTION
1	Panel lights with dimmer.
1	Uninterrupted power supply(described above)

1	Uninterrupted power supply battery pack(described above)
1	Four port Gateway / input (described above)
1	Four port Gateway / output (described above)
1	DMX splitter(described above)
1	Network hub (described above)
1	Network patch bay (described above)
1	4u locking drawer

c. Middle Atlantic is the basis for design; acceptable manufacturers are Hoffman, and Rittal.

2.16 BLACK BOX DMX DISTRIBUTION

A. General Description: Provide a 4 way DMX opto-slpyteer for DMX control distribution to plug boxes located on the Black Box side walls and in the Black Box pipe grid. See drawings for additional information

B. General

1. The eDIN DMX Installation Repeater shall be a factory-assembled, pre-wired, contractor-ready wall mounted panel.

2. The Installation Repeater shall permit star-wiring of DMX512 lighting control data signals and shall isolate and protect DMX transmitters and DMX receivers from high common mode voltages, ground loop currents and other potentially damaging electrical faults.

3. The Installation Repeater shall have one each 4 input port(s) and four out ports.

4. There shall be no in-line processing of the input signal to ensure that the output signals are all exact duplicates of the input signal.

5. DMX signal isolating/splitting shall be accomplished using standard 4-way DIN-rail mounted modules for easy expansion and/or servicing.

6. The system shall be capable of repeating simplex protocols other than DMX512, provided they meet the electrical requirements of EIA-RS422 or RS485.

C. Features

1. Each 4-way DMX repeater module shall incorporate LED indicators for DC power input, isolated DC power, DMX input and output data present for each port.

2. Each module shall provide a user-settable DMX input termination switch.

3. It shall be possible to daisy-chain all modules on the same DMX universe or connect separate universes to each module.

One (1) DMX pass-thru port shall be provided on each module. The pass-thru port shall be passive, i.e. direct-wired from the input and not repeated, such that failure of any one module shall not adversely affect a DMX signal being passed through to other modules or devices.

5. Each output shall be capable of driving up to 32 DMX receiving devices over a maximum 500-meter (1600-ft.) length of data cable.

Electrical

1. The power supply shall be a DIN-rail mounted, field-replaceable, wide-range input (115/240VAC, 50/60 Hz), UL-listed switching power supply, sized according to the maximum number of modules the cabinet can accommodate.

2. There shall be 2500-volt electrical isolation between input and output sections of the supply.

3. All DMX input and output ports shall be capable of withstanding short-term application of up to 250V without damage to internal components.

4. Port protection shall be of the self-healing type, rated for 250V. Replaceable fuses shall not be acceptable.

5. The DMX input port shall provide 1500-volt optical isolation between the input signal wiring and output signal wiring.
6. DMX outputs are electrically common with each other, i.e. non-isolated, but shall be floating with respect to earth ground.
7. DMX outputs shall provide self-healing protection against ground loops between adjacent ports.

E. Physical

1. The DMX Installation Repeater cabinet shall be a NEMA 1 enclosure, constructed of 18 gauge sheet steel, finished in textured black powder epoxy, with a non-louvered, formed aluminum cover.
2. The cabinet shall be designed for surface mounting.
3. Dimensions shall be 10.25”w x 13.25”h x 4.5”d (260mm x 335mm x 120mm) for 4-output models.
4. The cabinet shall be furnished with ½” and ¾”conduit knockouts, internal high voltage barriers as required, and be clearly labeled “Pathway eDIN System”.

F. Field Wiring Connections

1. All internal field wiring connections shall be clearly labeled according to their function.
2. Connections for DC power and all data input, output and pass-thru ports shall be two-part, Phoenix-type screw terminal strips, capable of accepting #24 to #16 gauge solid or stranded wire.
3. A DMX pass-thru connection shall be provided to allow daisy-chaining of additional modules, Installation Repeaters, or other DMX equipment.
4. AC power supply connections shall be capable of accepting up to #12 gauge solid or stranded wire. A suitable terminal shall be provided for ground wire connection.

G. Environmental

1. The ambient operating temperature shall be -10° to 50°C (14° to 122°F).
2. The storage temperature shall be -40° to 70°C (-40° to 158°F).
3. The operating humidity shall be 5% - 95% non-condensing.

H. Compliance

1. The DMX Installation Repeater shall meet the requirements of ANSI E1.11 DMX512-A and USITT DMX512 (1990).
2. The DMX Installation Repeater shall be ETL-listed.
3. The DMX Installation Repeater shall be compliant with the EU RoHS 2002/95/EC directive.
4. The DMX Installation Repeater shall conform to FCC requirements.
5. The repeater module(s) shall be a Class 2 Low Voltage device(s).

I. Acceptable Product

1. The 4-Way DMX Installation Repeater(s) shall be Pathway eDIN model #4807 or approved equal.

2.17 AUDITORIUM STAGE LIGHTING CONNECTOR STRIPS

A. The stage lighting connector strips shall be provided by the stage rigging contactor as part of the stage rigging hoisting systems. See stage lighting and stage rigging drawings for complete information. Coordinate all requirements with the stage rigging contractor.

2.18 AUDITORIUM AND BLACK BOX STAGE LIGHTING PLUGGING BOXES

A. Surface Mount Outlet boxes shall be fabricated from 16-gauge steel with a fine-texture, scratch-resistant, powder-coat finish. Outlets shall be 3-pole 20A grounded flush mount twist lock L5-20 female connectors for 120V relay circuits. Circuits shall be individually indicated with ¾” white die

cut adhesive labels. Boxes shall be equipped with grounding lugs. All faceplates to match outlet box enclosure dimensions with no sharp edges exposed. Basis of design is ETC alternative manufacturers are Strand Lighting Inc., SSRC, LEX or an approved equal.

B. Flush Mount Outlet boxes shall be fabricated from 16-gauge steel with a fine-texture, scratch-resistant, powder-coat finish. Outlets shall be 3-pole grounding of, 20A grounded flush mount twist lock L5-20 female connectors for 120V relay circuits. Circuits shall be individually indicated with ¾" white die cut adhesive labels. Boxes shall be equipped with grounding lugs. All faceplates to match outlet box enclosure dimensions with no sharp edges exposed. Basis of design is ETC alternative manufacturers are Strand Lighting Inc., SSRC, LEX or an approved equal.

C. Pipe Mount Outlet boxes shall be fabricated from 16-gauge steel with a fine-texture, scratch-resistant, powder-coat finish Outlets shall be 3-pole grounding of, 20A grounded flush mount twist lock L5-20 female connectors for 120V relay circuits. Circuits shall be individually indicated with ¾" white die cut adhesive labels. Boxes shall be equipped with grounding lugs. All faceplates to match outlet box enclosure dimensions with no sharp edges exposed. Provide with U-Bolt type mounting bracket for mounting the Black Box pipe grid. Basis of design is ETC alternative manufacturers are Strand Lighting Inc., SSRC, LEX or an approved equal.

D. Furnish all the plugging boxes for performance lighting circuits, see distribution detail drawing for circuit designations and quantities and see device location drawing for locations.

2.19 AUDITORIUM GRID IRON JUNCTION BOXES

A. General

1. Gridiron junction boxes shall be fabricated from 14 gauge cold rolled steel with 14 gauge end panels.
2. Junction boxes shall be finished with fine-textured, scratch-resistant, black powder coat.
3. Junction boxes shall include mounting brackets and hardware
4. Cover(s) shall be 16-gauge cold rolled steel and hinge to allow installer to orient the hinged door to open in any horizontal direction.
5. Cover(s) shall be secured with machine screws and Tinnerman retainer nuts.

B. Electrical

1. Wiring terminations shall be made using feed through terminals individually labeled with corresponding circuit numbers.
   a. 20 amp circuits shall use screwless tension clamp terminals listed for 20 – 8 gauge wire.
   b. 50 amp circuits shall use compression terminals listed for 10 – 1 gauge wire.
   c. 100 amp circuits shall use compression terminals listed for 8 – 2/0 gauge wire.
   d. Terminals that place a screw directly on the wire are not acceptable.
2. Gridiron junction boxes shall be listed by a nationally recognized test lab (NRTL).
3. A low voltage distribution system shall be available to incorporate DMX, Ethernet or other protocols as specified with the gridiron junction box.
   a. Low voltage junction boxes shall attach to gridiron junction boxes to simplify wiring to a discrete device
   b. Low voltage signals shall enter the junction box via a strain relief or connector mounted in a separate low voltage terminal box on the top or bottom of the gridiron junction box.
   c. Up to four low voltage cables shall be supported for each junction box location.

C. Coordinate with the stage rigging contractor and division 26 contractors. See lighting device location and system one line drawings for placement and quantities, and distribution detail drawings for circuit designations.

2.20 AUDITORIUM STAGE LIGHTING FIXTURES

A. All LED lighting fixtures shall include a C-clamp, a safety cable w/spring clip, a male L5-20 to instrument power cable (plug type for power input at instrument is determined by manufacturer), a power thru jumper cable and a DMX male 5 pin to female DMX 5 pin thru jumper cable. Lengths of cables to be sufficient to reach circuits as shown on the drawings and nearest control network gateway.

B. Cyclorama LED lighting fixtures shall be individually adjusted as needed to produce consistent single color wash.

C. Furnish and install the following theatrical lighting fixtures in the Auditorium. See fixture plot for quantities.

CAT.#	DESCRIPTION
Electronic Theatre Controls, Inc. ColorSource LED OR equal by Strand, Chauvet, OR Altman	14 Degree 115 volt LED ellipsoidal reflector spotlight
Electronic Theatre Controls, Inc. ColorSource Spot LED OR equal by Strand, Chauvet, OR Altman	19 Degree 115 volt LED ellipsoidal reflector spotlight
Electronic Theatre Controls, Inc. ColorSource Spot LED OR equal by Strand, Chauvet, OR Altman	26 Degree 115 volt LED ellipsoidal reflector spotlight
Chauvet Ovation B-565FD or equal by Strand, ETC, OR Altman	120V, 125W LED Wash fixture, 5 color (red, green, blue, amber, and lime)
Electronic Theatre Controls, Inc. ColorSource CYC LED, OR equal by Strand, Chauvet, OR Altman	115 volt LED cyclorama fixture
Altman WL-130 or equal by ETC, Strand, OR Chauvet	120V, 130W LED work light fixture, 3000K color temperature, minimum 90 CRI

2.21 BLACK BOX STAGE LIGHTING FIXTURES

A. All LED lighting fixtures shall include a C-clamp, a safety cable w/spring clip, a male L5-20 to instrument power cable (plug type for power input at instrument is determined by manufacturer), a power thru jumper cable and a DMX male 5 pin to female DMX 5 pin thru jumper cable. Lengths of cables to be sufficient to reach circuits as shown on the drawings and nearest control network gateway.

B. Furnish and install the following theatrical lighting fixtures in the Black Box. See fixture plot for quantities.

CAT.#	DESCRIPTION
Electronic Theatre Controls, Inc. ColorSource Junior LED OR equal by Strand, Chauvet, OR Altman	Zoom Type 115 volt LED ellipsoidal reflector spotlight
Chauvet Ovation B-565FD or equal by Strand, ETC, OR Altman	120V, 125W LED Wash fixture, 5 color (red, green, blue, amber, and lime)

2.22 STAGE LIGHTING ACCESSORIES

A. Furnish the following stage lighting accessories to be made available to all venues.

B. Provide all type S L5-20 jumpers and twofers required to cable the light plot and furnish the following jumpers. All jumpers shall have color coded length labeling at both ends of the cable. Lex Products Stage cable is the basis of design or an approved equal.

1. 15 each 5'-0", 12 AWG, type S extension cables w/male and female L5-20 connectors installed.
2. 15 each 10'-0", 12 AWG, type S extension cables w/male and female L5-20 connectors installed.
3. 10 each 25' -0", 12 AWG, type S extension cables w/male and female L5-20 connectors installed.
4. 6 each 50' -0", 12 AWG, type S extension cables w/male and female L5-20 connectors installed
5. 15 each 2-Fers, Lex Products # 3123J-l520, for interconnection of fixtures.

C. Provide all 5 pin DMX jumpers required to cable the light plot and furnish the following jumpers. All jumpers shall have color coded length labeling at both ends of the cable.

1. 10 each 5’ male DMX 5 pin to female DMX 5 pin cables.
2. 10 each 10’ male DMX 5 pin to female DMX 5 pin cables.
3. 5 each 25’ male DMX 5 pin to female DMX 5 pin cables.
4. 5 each DMX 5 pin terminators.
5. 10 each 5’ male DMX 3 pin to female DMX 3 pin cables.
6. 10 each 10’ male DMX 3 pin to female DMX 3 pin cable
7. 5 each 25’ male DMX 3 pin to female DMX 3 pin cables.
8. 5 each DMX 3 pin terminators.
9. 5 each male 5 pin to female 3 pin DMX turnarounds.
10. 5 each female 5 pin to male 3 pin DMX turnarounds.

D. Cable length color coding shall be the same for both power and control cables.

E. Fixture Accessories

1. 10 each Drop in Iris units for ellipsoidal stage lighting fixtures.
2. 10 each half hats

F. Ten (10) each Pattern holders for ellipsoidal spotlights.

G. Patterns (Gobos) as follows:

a) 8 each GAM #222
b) 8 each GAM #294
c) 2 each GAM #201
d) 2 each GAM #204

H. 5 each roll of black wrap

I. 1 each 600’ roll of black tie line

For the Black Box, provide a mobile production workbench for the control console and accessories. Provide one (1) Global Industries 48”W x 30” deep Mobile Production Workbench, Part No. T97319365BL or approved equal.

PART 3 - EXECUTION

.1 STANDARDS COMPLIANCE

A. Comply with all local building codes.

B. In the absence of specific local codes, comply with the National Electrical Code (NFPA-70) as applicable to installation and construction of stage lighting and control equipment.

C. Where not in conflict with local building codes or the National Electrical Code comply with industry standard professional practices.

D. Installation practices shall be in accordance with OSHA Safety and Health Standards.

3.2 SHOP DRAWINGS

A. Submit within thirty (30) days of the bid acceptance, for review and approval by the Owner, Architect, and Consultant:

1. Complete shop drawings and data sheets for all items specified.

2. Complete shop drawings for all components, assemblies, sub-assemblies, cabinets, wiring devices and hardware required to implement the work.

3. Riser diagrams showing all quantities, types and sizes of inter-connection wires to be installed by others.

4. Schematics of all block assemblies and sub-assemblies, including pin out identification of all low voltage cable connectors.

5. Approval of shop drawings does not relieve the Contractor of the responsibility of providing equipment in accordance with these specifications. Any deviations from the specifications shall be "starred" and noted in 1/4" high letters. Only deviations, which upgrade the quality of the equipment, shall be considered.

6. In addition to drawings, the Contractor may elect to submit catalog cuts for certain standard equipment items. These shall contain full information on dimensions, construction, applications, etc. to permit proper evaluation. In addition, they shall be properly identified as to their intended use and any options or variations shall be clearly noted.

7. Samples may be requested by the Architect and shall be furnished for inspection at the Architect's office, at the Contractor's sole expense.

8. Prior to the commencement of fabrication and delivery, the Contractor shall submit for approval, to the Architect, an outline of a proposed coordinated and completion schedule of project requirements.

3.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver stage lighting equipment and controls to job site securely wrapped in containers.

B. Coordinate delivery dates with the Division 26 contractor

C. All equipment shall be stored in a clean, dry space.

D. Discrepancies in quantities or missing equipment shall be noted, in writing, and brought to the attention of the manufacturer within five days of receipt.

E. Replacement of missing or damaged equipment shall be the responsibility of the Contractor.

F. Handle equipment and controls carefully to prevent breakage, denting and scoring finish.

G. Replace and return damaged units to equipment manufacturer immediately.

H. Store in original cartons and protect from dirt, physical damage, weather, and construction traffic.

3.4 INSTALLATION

A. The Contractor shall furnish, deliver, install and terminate all system control wires.

1. All cables shall be permanently labeled at every termination. The label shall not be hand written. Clear heat shrink shall cover the label.

2. Service loops of not less than 6" shall be present at all terminations to equipment.

3. All pulls to be made by hand, care shall be taken not to nick cable jackets, and any nicked or damaged cable shall be replaced.

4. A pull string shall be left in all conduits after wire is installed.

5. Splices in conduit shall not be permitted.

6. Include spare cables with all field runs. Quantity to be 10% or 1 whichever is greater unless otherwise specified.

7. Where shielded cable is in use leave shield drain wire the same length as the circuit conductor(s), sleeve shield drain wire in green PVC tubing. Cap where the cable jacket was removed with heat shrink. Where the shield drain wire is to be lifted follow the above and fold back over cable jacket. Then cap end with heat shrink. Do not use a single piece of heat shrink for this use two smaller ones.
8. All soldering shall be clean and neat and not exhibit evidence of a " cold" joint, were necessary heat sinks shall be used. Use only rosin core "electronic type" solder.
9. Wire nuts shall not be permitted.

B. The Contractor shall furnish and install all system control devices.

C. The Contractor shall hang and aim the stage fixture hanging plot.

1. Provide the Theatre Consultant fourteen (14) days' notice prior to this work being scheduled.
2. The Theatre Consultant shall verify the aiming of the stage fixtures.

D. The installation of all work shall be neat.

E. All boxes and equipment shall be installed plumb and square.

F. The installation shall conform to the plans and spec.

G. The contractor shall not commence the installation of equipment and devices, other than the pulling of cable, until all areas are clean, painted and finished to a point that they shall be completely dust, dirt, lint, fiber and airborne particle free. The air conditioning system must be operating to its design level and be able to keep all areas with control equipment suitable.

3.5 INSTALLATION COORDINATION

A. The Contractor shall specifically coordinate the placement and sizes of conduit relating to this work and shall specifically review and approve the conduit rough-in in time to advise all parties of needed changes, omissions, etc.

B. The Contractor shall report this unsuccessful coordination in writing to the Architect.

C. If any conflicts or omissions occur as a result of the Contractor's unsuccessful coordination of the above-mentioned work, it shall be the Contractor's responsibility to correct, furnish and install any additional material that may be required.

D. The contractor shall at all times coordinate his work with the other trades to ensure smooth progress of work and satisfactory final results.

E. The Contractor shall examine areas and conditions under which stage lighting and controls shall be installed and notify the Architect in writing of conditions detrimental to proper installation and operation.

3.6 INSPECTION AND TESTING:

A. During the installation of the equipment the contractor shall arrange for access as necessary for inspection of equipment by the owner's and/or architect's representatives.

B. Provide a safe means of accessing all system components for all visits.

C. Equipment Pretesting: All racks shall be built and wired in contractors shop and tested prior to delivery to site. All other equipment shall be tested prior to delivery and installation. A written test report shall be submitted to the owner.

D. Final Inspection:

1. The final inspection shall confirm that the systems, as installed, meet the requirements of this spec, the contract documents, and the approved contractor's shop drawing and submittals.
2. The contractor shall inform the owner in writing of the system's completion. The contractor shall then request final inspection by the consultant, and carry out the necessary coordination. This coordination includes:

a. Giving at least fourteen days' notice to the consultant prior to the final inspection.

b. Arranging for the contractor's and consultants exclusive use of the space.

c. Arranging for a HVAC technician to be available to turn the AC system on and off.

d. Arranging for a sound technician to be available to control the sound system.

e. The contractor's job foreman and one additional worker familiar with the job shall be present during all check out, testing and inspection.

3. Contractor shall complete the following tasks prior to consultant's arrival:

a. Unpack and assemble all portable equipment.

b. Place all portable equipment in one location.

c. If anything has been turned over to the owner have the signed Letters of Transmittal on site.

d. Complete all required paperwork (pre-testing reports, letters indicating successful coordination of the installation, etc.).

e. Provide all lighting network certification reports.

f. Remove all security covers.

g. Contractor shall provide all necessary software, cables, and interfaces to facilitate the setting of computer controlled, remote controlled or digitally controlled equipment.

4. Contractor shall provide the following test equipment for use during inspection and acceptance testing:

a. Some type of light meter

b. Some type of DMX checking device

c. Some type of Multi-meter.

d. Contractor shall provide the means to access all system components during the entire commissioning process.

e. Contractor shall provide personal and equipment to make any adjustments to the theatrical lighting system(s), as well as to correct problems, for the entire inspection and testing period.

E. The Theatre Consultant or his representative shall conduct all final system tests in order to determine final acceptance.

F. In no event shall the theatrical lighting systems installation be submitted for final approval or acceptance until any and all elements of the facility that may have a bearing on the system performance, including but not limited to doors, windows, HVAC, carpeting, furniture, wall coverings, stage flooring, rigging systems, interior design elements, architectural lighting and lighting control systems have been completed and shall be operable. All elements that may affect stage lighting system's operation or performance shall be "on" and operating during adjustments. The stage lighting contractor shall be responsible for coordinating the requirements of this paragraph with other work on the project.

G. Equipment Backorders. Should any component or equipment be on backorder at time of system inspection and testing the contractor shall provide comparable loaner equipment at contractor's expense. Said equipment shall remain on-site until backordered equipment is delivered and installed.

3.7 MANUFACTURER'S SERVICES

A. The Contractor shall provide for:

1. A manufacturer's field service engineer to perform initial system activation. Under no circumstances shall power be applied to any equipment prior to initial system activation.

2. The manufacturer's field service engineer shall inspect and confirm that all low voltage terminations are correct.

3. Such engineering services shall be furnished within twenty-one (21) days of a written request by The Contractor.

3.8 TRAINING AND INSTRUCTION

A. The Contractor shall furnish sixteen (16) hours of onsite instruction to Owner designated persons. This instruction shall happen on four occasions. The general conditions require all training sessions to be videotaped. This contractor is to coordinate with this requirement and if required perform the taping.

1. The first occasion shall take place at the time of initial system activation and be performed by the manufacturer's field service engineer. The duration of this occasion shall be not less than three (3) hours. This instruction shall cover all aspects of operation and maintenance required by system.

2. All other occasions shall be coordinated with the owner representative and Contractor with (21) days written notice. This instruction shall be an overall review of the system operation and detailed console operations. The finial occasion shall take place within the last six months following system activation.

B. Provide operational assistance for the first usage of the system. This shall be at the owner's time schedule but, not to exceed 8 hours.

3.9 MANUALS

A. Upon completion of the work, the Theater Equipment Contractor shall submit four detailed printed copies of Operations and Maintenance Manuals for each system, 2 for the Owner, and 1 for the Architect/Engineer of Record and one for Consultants. The Contractor shall also provide CD-ROM's with the Operations and Maintenance Manuals in PDF format with a hyper link table of contents, also any and all CAD drawings including as-built shop drawings, equipment descriptions, any required certificates or warranties, and parts lists or other electronically produced submittal items. The contractor shall also provide a USB flash drive for each space with all project documents including the initial configuration files for the control electronics modules for the stage lighting dimmers and house light dimmers, the stage lighting consoles, the stage lighting network switches, the portable network nodes and all multi parameter stage lighting fixtures. Submit in quantities and file formats as required by the Architect.

B. Additionally, inside the primary dimmer or auxiliary control rack, provide a document pouch and one set of final as-built drawings. Before distribution of manuals submit one copy to consultant for approval. Each manual is to contain the following:

1. System one-line drawings including all labeling and changes ("as builts ").

2. Owner's manual for each piece of equipment.

3. Schematic diagram for each piece of equipment.

4. Contractors service phone number in a conspicuous place.

5. All test reports.

3.10 WARRANTIES

A. Contractor shall warrant the system to be free from defects in materials and workmanship for a period of one year from the date of acceptance, or first beneficial use, whichever comes first. Acts of God and owner abuse or neglect shall be not covered.

B. During the warranty period the contractor shall respond to and correct any call for service within one day of the call.

C. Loaner equipment shall be provided if necessary.

D. The manufacturer of the stage lighting and control equipment shall warranty the electrical distribution, dimming and control equipment to be free from defects of material or workmanship for a period of two years from the date of acceptance.

E. The manufacturer shall warranty all fixtures and accessories (except lamps) to be free from defects of material or workmanship for a period of one year from the date of acceptance. During the period of

this warranty, equipment that proves to be defective shall be repaired or replaced at no charge (excluding freight). Unauthorized local repairs of equipment during the warranty period shall relieve the manufacturer of his responsibilities under this warranty.

F. Include the name, address, and phone number of at least two (2) factory authorized Field Warranty centers within a 250-mile radius of the job site in the operation and maintenance manual.

3.11 FINAL ACCEPTANCE

A. The following conditions must be met before final acceptance shall be granted:

B. Inventory of all equipment by the project Architects or his representative.

C. All inventoried portable equipment is in secure storage, accessible only by the Owner.

D. Approval of final tests and inspections by the project Architects, Theatre Consultant, and Owner.

E. Submittal to the Architect of three (3) signed copies of all warranties.

F. Satisfactory completion of all punch list items.

G. At the date of system activation, the Contractor shall furnish and replace all lamps in stage lighting fixtures, which are observed to be noticeably dimmed, as judged by the Architect or his representative.

END OF SECTION 265501

SECTION 265562 - BROADCAST STUDIO LIGHTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for the complete and proper operation of the lighting control system and rigging systems.

B. Specification Includes

1. Systems:

a. Smart Track and Smart Theatrical Dimming
b. Lighting Fixtures and Support Hardware

2. Provision of materials, components, modifications, assemblies, equipment, and services as specified herein. These include, but are not limited to:

a. Verifications of site dimensions and conditions
b. Manufacturer submittals (6 copies min)
c. Electrical Drawings for permit as required by contract documents
d. Engineering of equipment and systems as required by contract documents
e. Scheduling, sequencing, and coordination of sub-contractors
f. Installation and onsite supervision for all equipment and systems specified herein.
g. Testing and demonstration of equipment and systems as specified herein.

C. The requirements of Division 26 apply to all the electrical work included in this section, unless specifically directed otherwise.

1.3 ALTERNATES

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

1.4 REFERENCE STANDARDS

A. National Fire Protection Associations (NFPA) Publications: National Electrical Code, NFPA 70.

B. Underwriters Laboratories Standards:

1. UL498, Electrical Attachment Plugs and Receptacles

2. UL508, Electrical Industrial Control Equipment

3. UL891, Dead-Front Electrical Switchboards

4. UL1573, Stage and Studio Lighting Units

C. United States Institute for Theatre Technology Standard: DMX512/1990, Digital Data Transmission Standard for Dimmers and Controllers

D. United States Institute for Theatre Technology Standard: CAN

E. Institute of Electrical and Electronics Engineers, Inc:

1. Standard: 802.3

2. Standard: 802.11 b or g

F. American National Standards Institute (ANSI)

G. International Building Code (IBC)

H. State and/or Local Electrical Code

1.4 FIELD CONDITIONS

A. All bidders shall fully inform themselves of the conditions under which the work is to be performed. No additional compensation shall be allowed for any labor or materials that the bidder could have been fully informed of prior to bid date.

1.5 SAFETY

A. The systems, and all components, shall conform to all applicable code requirements and shall be in conformance with industry standards of operation and practices. All materials, arrangements, and procedures shall comply with applicable code requirements, allowing the users to arrange and operate a safe assembly and working environment audience and user personnel.

1.6 QUALITY ASSURANCE

A. Manufacturer shall be one who has been continuously engaged in the manufacturer of lighting control equipment for a minimum of ten years.

B. The manufacturer shall have a factory authorized stocking service center with at least two full time service technician on staff located within 100 miles of the job site. In addition, the manufacturer shall have a toll free 24-hour hotline with a maximum response time of 20 minutes, 24 hours a day and 365 days a year.

C. All equipment, where applicable standards have been established, shall be built to the standards of Underwriters Laboratories, Inc., the National Electrical Code and the United States Institute for Theater Technology. Permanently installed power distribution equipment shall be UL and C-UL Listed, and/or CE marked (where applicable) and bear the appropriate labels. Portable equipment such as consoles and fixtures shall be UL and C-UL Listed, ETL Listed and/or CE marked (where applicable) and bear the appropriate labels.

1.7 SUBMITTALS

A. Project Data: For each product specified, indicating configurations, finishes, and dimensions.

B. Shop Drawings: Contractor shall prepare and submit shop drawings including, but not limited to, floor plans indicating equipment locations to ensure coordination with other Divisions, as well as wiring diagrams indicating power and control requirements for luminaires, dimmers, etc.

C. Contractor shall furnish any additional information, including equipment demonstration, as required by the Architect/Engineer to verify compliance with specifications.

1.8 WARRANTY

A. Provide warranty for system and equipment to be free of defective components, faulty workmanship, and improper adjustment for a min period of two (2) years from the date of acceptance by the Owner's Representative. Paint and exterior finishes are excluded from this warranty but must be in a new condition upon acceptance.

B. Replace items showing evidence of defective materials or workmanship within thirty (30) days after written notification.

C. Rectify conditions that might present a hazard to human life, well-being, or property within forty-eight (48) hours.

1.9 EXTRA MATERIALS

A. Provide 10% spare lamps, but no less than one (1), of each lamp type provided.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Altman Stage Lighting Company, Inc.
2. Chauvet
3. Electronic Theatre Controls, Inc.
4. Lehigh Lighting
5. Strand Lighting
6. Times Square Lighting

2.2 "SMART TRACK" LIGHTING SYSTEM

A. General

1. The Lighting System shall consist of high quality aluminum lighting track with integral data distribution, rugged multi adapters to support fixtures and to transfer power and data from the track to devices mounted on the track system, and controllable devices such as lighting fixtures. The Lighting System shall be the Smart-Track System as manufactured by Altman Stage Lighting, or approved equal.

2. Track Sections shall distribute (1) or (2) 20 amp 120 VAC power circuits and shall include integral distribution of DMX-512A (ANSI E1.11-2004) and RDM (ANSI E1.20-2006) control signals to lighting fixtures and controllable devices mounted on the Smart Track. Connection of a "smart" lighting fixture to the Smart Track shall automatically connect it to the data network.

3. The Lighting System provide for the connection and control of a variety of load types, including:

   a. Quartz-Halogen

   b. Low Voltage

   c. CDM (Metal Halide)

   d. LED (Light Emitting Diode)

4. Each load or fixture in the lighting system shall incorporate its own dimmer, relay, or LED driver. Submittals for systems requiring installation and provision of dimmer panels, relay panels, or external LED Drivers shall be rejected without review.

5. Each load or device connected to the Lighting System shall be independently controlled via a unique digital address. Control zones shall be determined on a fixture by fixture basis, shall be field changeable, and shall be completely independent of circuitry and wiring used to power the load.

6. The Lighting System shall be compatible with any Lighting Controller fully compliant with the DMX-512A (ANSI E1.11-2004) standard. Connection points shall be provided for both wired and wireless connection of controls to the Lighting System.

7. The Lighting System shall have a complete line of components to join data and electrify separate tracks, including:

   a. Live and Dead End Feeds

   b. In-line couplers

   c. Feed thru connectors

   d. L turns (left and right)

   e. X-connectors

   f. Data Terminators

   All components of the Lighting System shall be U.L. or ETL listed.

B. Components

1. Track System

   a. Track Sections shall include one (1) or two (2) separately switchable circuits with independent and dedicated neutral conductors as well as associated couplers, feeds, and terminators.

   b. Track Sections shall include a data bus track with two (2) 22-gauge nickel plated copper conductors integrated into the bottom slot of the track for distribution of DMX-512A and RDM control signals.

1) Data can be accessed anywhere along the track.

2) Adaptors without bus contacts also can use the 2 circuit track with data bus, but without DMX-512A and RDM functions.

c. Track Sections shall consist of the following:

1) An extruded aluminum housing measuring 1-1/4" x 1-3/4". Track sections shall be available in precut lengths of 4', 8', or 12'.

2) The extruded aluminum housing shall also function as ground.

3) Track sections shall include two inserted plastic profiles carrying up to four (4) embedded 12-gauge copper conductors.

d. Mounting and Installation:

1) It shall be possible to field cut Track sections to necessary lengths for each project and location. It shall not be necessary to cut back or bend back the conductors after field cutting of track sections.

2) Track Sections shall have pre-punched holes for mounting every 8" on center.

3) The top of the track shall have an extruded profile to allow for the mounting a manufacturer supplied bracket/hanging supports for connecting with contractor supplied chain, cable, or threaded rod.

e. Track Sections shall be available in white, black, or silver finish.

2. Multi Adapter

a. Multi Adapters shall be rugged, highly compact components that connect lighting fixtures and other controllable devices to the Smart Track system.

b. Multi Adapters shall include a double lock mechanism allowing for connection of 2 maximum spotlights:

1) One mechanical lock shall securing the adapter to the track.

2) One mechanical lock shall connect the power contacts and shall be sued for selecting circuit 1, circuit 2 (2-circuit tracks only), or "off".

c. Multi Adapters shall include the following features:

1) Wiring terminals and nickel plated spring contacts.

2) Approval and listing for 120V.

3) Integral ground contact and on/off switch.

4) Support a maximum load up to 22 lbs.

d. Multi Adapters shall be constructed of self-extinguishing polycarbonate according to class V0.

e. Multi Adapters shall be available in white, black, or silver finish.

3. Luminaires

   a. Fixtures for use on the DMX track system shall consist of a family of luminaires designed with an on board DMX interface and an installed Multi Adapter designed to mechanically hang, power, and feed data.

   b. Fixtures shall be of three types; LED, Quartz, and Metal Halide

      1) LED color changing luminaires shall be available as three types; fixed color temperature white, color temperature control white, or color mixing (RGB or RGBA). LED fixtures shall feature integral power supplies, drivers, and DMX interface and pre-programmed modes.

      2) Quartz fixtures shall have an integral, on board electronic phase-forward (leading edge) dimmer compatible with incandescent, low voltage, and certain phase-dimmable LED loads.

      3) Metal Halide (CDM) fixtures shall have an on board DMX on/off relay. Relay rated for 70 watts maximum.

   c. DMX addressing for all system fixtures shall be connected via manual setting of the rotary dials for Dimmer and CDM luminaires and push button for LED or via RDM from a remote location with a Remote Authorization Device.

      1) The units shall be supplied with two dip switches to change modes from DMX, RDM, manual over ride, dimmer control and full on power mode.

      2) All fixture dip switches and dials will be concealed by a latch that requires the use of a screwdriver to access and make changes.

      3) Luminaires shall retain their identity and programming, even when moved to a new location and the comma.

      4) Data input on all fixtures will have high voltage protection circuitry.

   d. Fixtures may be connected to the system at any point along the track.

   e. Fixtures equipped with Multi Adapters without data bus contacts may be used to connect standard lighting fixtures to the power distributed by the track, without connection to control functions.

   f. All fixtures shall be U.L. or ETL listed.

C. Data Distribution, Wiring, and Connection

1. Control wiring shall be suitable for transport of DMX-512A (ANSI E1.11-2004) and RDM (ANSI E1.20-2006) control information between the output of the lighting control system and smart track sections and/or other DMX-controlled devices.

2. Maximum overall length of each control segment as measured from the output of the control system (and related RDM compatible signal splitters or amplifiers), including control cable and smart track sections, shall not exceed 1000'.

3. Control segments shall be installed as daisy chain topology only. "T-tap" or "star" type installations shall not be allowed.

4. Each control segment shall be terminated with a 120ohm resistor as specified by DMX-512A (ANSI E1.11-2004) Standard.

5. Maximum number of recommended devices per segment shall not exceed (32). Each individual Luminaire with associated driver/dimmer/ relay shall count as ¼ device.

6. Contractor shall furnish and install suitable DMX-512A (ANSI E1.11-2004) cont cabl as recommended by the manufacturer of the control system procured and installed fo is project.

D. Provide Smart Track sections, hardware, luminaires, and accessories as require exec the designs shown on Contract Documents.

2.3 SMART THEATRICAL DIMMERS

A. General:

1. The instrument shall be a Smart Theatrical Dimm STD as m nufactured by Altman Stage Lighting, Inc., or approved equal.

B. Dimmer:

1. Compatible with all phase-forward mmab s 600 watts, 120 volt.

2. Mount directly to the hanging yoke of p form ce lighting fixtures.

3. DMX-512A and RDM ible via integrated 5-pin XLR connectors.

4. Integrated 5 amp, volt button breaker.

5. Convection o fa

C. Basis of Desig

1. Altm n Ca og No. D-600, or approved equal.

2.4 LIGHT E TTIN DIODE (LED) WASH FIXTURES

A. Descript The instrument shall be a LED wash lighting fixture as manufactured by Altman Stage Lighting, Inc., or approved equal.

B. Physical:

1. Pre-programmed modes for fixed colors, timed color changes and strobe.

2. Convection cooled.

3. Construction shall be corrosion-resistant materials and hardware.

4. Black finish.

C. Electrical:

1. The fixture shall be equipped with 120V to 240V 50/60 Hz internal power supply.

2. Feed through power and data capabilities.

3. Compatible with DMX and RDM protocols.

D. LEDs:

1. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.

2. LEDs shall have 3000K CCT per ANSI C78.377, and shall have a maximum deviation of 3-step MacAdam ellipses.

E. Accessories:

1. Provide the following accessories for each fixture:

a. 4-leaf barn doors, black finish.

b. Louver, black finish.

c. All mounting hardware for installation on smart track.

d. Black safety cable with spring clip.

F. Basis of Design: Altman Lighting Spectra Cube SCUBE-3K-B, or approved equal.

2.5 LIGHT EMITTING DIODE (LED) CYCLORAMA WALL WASH FIXTURES

A. Description: The instrument shall be a LED cyclorama wall wash lighting fixture as manufactured by Altman Stage Lighting, Inc., or approved equal.

B. Physical:

1. Pre-programmed modes for fixed colors, timed color changes and strobe.

2. Asymmetrical reflector.

3. Construction: To be corrosion-resistant materials and hardware.

4. Black finish.

C. Electrical:

1. The fixture shall be equipped with 120V to 240V 50/60 Hz internal power supply.

2. Feed through power and data capabilities.

3. Compatible with DMX and RDM protocols.

D. LEDs:

1. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.

2. LEDs shall have 3000K CCT per ANSI C78.377, and shall have a maximum deviation of 3-step MacAdam ellipses.

E. Accessories:

3. Provide the following accessories for each fixture:

a. Fiber Frame.

b. All mounting hardware for installation on smart track.

E. Basis of Design: Altman Lighting Spectra Cyc SSCYC50Y-3K-B, or approved equal.

2.6 LIGHTING CONSOLE AND ACCESSORIES

A. General

1. The lighting control shall be a microprocessor-based system specifically designed to provide complete control of stage, studio, and entertainment lighting systems.

2. The lighting console shall be capable of controlling the light sources indicated herein and/or in the "Platform Lighting Fixture" schedule on the contract drawing, indicating but not limited to LED light sources.

3. A maximum of 288 cues.

B. Interface Options

1. The console shall support a variety of local interfaces.

a. AC input

b. DMX out

c. MIDI Out

d. MIDI In

e. One VGA output connector.

C. Physical

1. All operator controls and console electronics for a standard system shall be housed in a single desktop console.

2. Console power shall be 95-240V AC at 50 or 60 Hz, supplied via a detachable power cord.

2.7 DMX ISOLATOR/SPLITTER

A. General:

1. Ensures optically safe DMX line splitting and isolation of DMX-512. Accepts a DMX control signal from the console and provided isolation between the control input and additional DMX feeds for dimmer packs and racks, lights, etc.

B. Inputs/Outputs

1. Control Input – Male 5-pin XLR DMX

2. Pass Thru – Female 5-pin XLR DMX (unbuffered)

3. Isolated Outputs – Quantity as required for system operation.

C. Electrical Characteristics

1. IEC flush mounted male, power cord included.

2. External switch for 110/220 volt operation.

3. Miniature fuse rated at 2 amperes for overcurrent protection.

D. Physical

1. Standard E.I.A. rack mountable.

2. 1.75" H x 19" W x 7"D

E. Provide LDMX series as manufactured by Leprecon, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. It shall be the responsibility of the Contractor to receive and store the necessary materials and equipment for installation of the dimming systems. It is the intent of these specifications and plans to include everything required for proper and complete installation and operation of the performance systems, even though every item may not be specifically mentioned. The Electrical contractor shall deliver on a timely basis to other trades any equipment that must be installed during construction.

B. The Contractor shall be responsible for field measurements and coordinating physical size of all equipment with the architectural requirements of the spaces into which they are to be installed.

C. The Contractor shall install electrical equipment in accordance with manufacturer's approved shop drawings.

3.2 START-UP AND DEMONSTRATION

A. A qualified Service Representative employed full time by the manufacturer shall visit the job site after the installation is complete and prior to the energization of the system to inspect, test and adjust the system.

B. Instruction shall be provided for the Owner's representatives in the operation and maintenance of the system. Provide a minimum of 4 hours of instruction, with a minimum of 14 days written notice to the Contractor.

3.3 MANUFACTURER'S WARRANTY

A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two years from date of delivery.

B. Warranty shall cover repair or replacement of such parts determined defective upon inspection.

3.4 CLOSE OUT DOCUMENTATION

A. The Contractor shall provide two sets of as-builts drawings which shall include marked up submittal drawings and electronic copies of all operational and maintenance manuals and system configurations.

END OF SECTION 265562

SECTION 265600 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. ALTERNATES

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

1.3. 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 265100, "Interior Lighting", for lighting fixtures installed on the exterior walls of the building.
2. Division 26 Section 260943, "Network Lighting Controls" for lighting control systems controlling exterior lighting.

1.4. 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.

1.5. 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 lamps for electrical ratings and photometric data. Include manufacturer and model number of fixture being submitted.
3. Lamp ANSI designation, initial and mean lumen output, average-rated hours of lamp life and lamp mortality curve, and color temperature and color rendering index.
4. Ballast ANSI designation; electrical characteristics, including voltages, lamp and line operating and starting amperes, watts and watt losses, percent of allowable line voltage

variation range and lamp crest factor; minimum lamp starting temperature; and normal and maximum ballast operating temperature.

5. Ballast CBM approval and UL listing, volts, lamp and input amperes, input watts, and minimum lamp starting temperature.
6. Poles and standards dimensions, details of hand holes and wire entries, mast or bracket arms and connection to poles, 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 its switching arrangements shown.

D. Submit pole load calculations, including EPA wind load calculations, for all poles. Calculations shall include all pole-mounted devices including luminaires, call stations, handholes, directional signs, and banners. Refer to this Section, Paragraph "Fixtures" for additional information. Wind resistance calculations shall be certified by a Registered Professional Engineer.

E. Submit point by point lighting calculations for layout shown on the Contract Drawings if utilizing lighting fixture(s) other than first-named fixtures in the "Exterior Lighting Fixture Schedule" on the Contract Drawings (Basis of Design). All calculations shall strictly comply with IES Standards. Indicate foot candle readings minimum 5'-0-inches on center and in the horizontal plane.

F. 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.

1.6. 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.

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 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.
5. UL 935, UL 1029, UL 542 – Ballasts
6. UL 496 – Lampholders
7. UL 924 – Emergency Lighting and Power Equipment

L. NFPA Compliance: Comply with applicable requirements of NFPA 70, 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.

1.7. 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 wrapping which properly protect fixtures from construction debris and physical damage.

E. Store exterior lighting fixtures in original wrappings in a clean dry place. Protect from weather, dirt, fumes, water, construction debris, and damage.

F. Handle exterior lighting fixtures carefully to prevent damage to housing, and lenses. 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.

1.8. 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.

1.9. EXTRA MATERIALS

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

1. LED Circuit Boards: 1 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.

1.10. COORDINATION

A. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include the products indicated on the "Exterior Lighting Fixture Schedule" on the Contract Drawings.

B. Data listed and model numbers shown in this Specification 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 fins/breathers for enclosed luminaires.

E. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit re-lamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during re-lamping 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 two-piece 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.

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. Osram
3. Philips
4. Samsung

B. Correlated color temperature (CCT): 3,000 Kelvin per ANSI C78.377, unless otherwise indicated.

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 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 in the Lighting Fixture Schedule.

2.8. SPLICES, TAPS

A. All splices underground in hand holes or other 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 260519, "Low-Voltage Electrical Power 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. 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. Ver[illegible] anchor bolt templates by comparing with actual pole bases furnished.
2. Finish for Parts Exposed to View: Trowel and rub smooth. Comply with Di[illegible]on [illegible] Section Cast in Place Concrete for exposed finish.

B. Install poles in compliance with ANSI C2, with Manufacturer's written instructions a[illegible]as fo[illegible]

1. Use web fabric slings (not chain or cable) to raise and set poles.
2. Mount pole to foundation with leveling nuts, and tighten [illegible]ts to [illegible]rque level recommended by pole manufacturer.
3. Secure poles level, plumb, and square. Provide shimming [illegible]d grouti[illegible] of pole base to maintain luminaire in a true vertical position.
4. Grout void between pole base and foundation. Us[illegible] [illegible]inkl[illegible] expanding concrete grout firmly packed in entire void space.
5. Use a short piece of 1/2 inch (13 mm) diameter [illegible]e to mak[illegible] a drain hole through grout. Arrange to drain condensation from interio[illegible] pole

C. Luminaire Attachment with Adjustable Feat[illegible]r Aim[illegible]: Attach luminaires and supports to allow aiming for indicated light distributio[illegible]

D. Lamp luminaires with indicated lamps acc[illegible]g to [illegible]nufacturer's written instructions. Replace malfunctioning lamps.

E. Install exterior lighting fixt[illegible]s at[illegible]cations and heights as indicated in accordance with fixture manufacturer's written i[illegible]tructio[illegible] applicable requirements of NEC, NECA's Standard of Installation, NEMA Stand[illegible]nd with recognized industry practices to ensure that lighting fixtures fulfill requi[illegible]nts.

3.4. UNDERGROUND DUC[illegible]LINES

A. Duct[illegible]ies sh[illegible] be polyvinylchloride (PVC) heavy wall plastic ducts for installation without conc[illegible] en[illegible]sement.

B. Conductor[illegible]WG 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. [illegible]t 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 100 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.

3.5. 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 "26 0526 "Grounding and Bonding for Electrical Systems".

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, exothermic welded to grounding conductor.

3.6. FIELD QUALITY CONTROL

A. Inspect each installed unit for damage. Replace damaged units.

B. Advance Notice: Give dates and times for field tests.

C. Provide instruments to make and record test results.

D. Tests and Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with power source, and as indicated.

1. Measure light intensities at night if specific illumination performance is indicated. Use photometers with calibrations referenced to NIST standards.
2. Check intensity and uniformity of illumination.
3. Check electronic LED drivers and circuit boards for proper operation.

E. Prepare a written report of tests, inspections, observations and verifications indicating and interpreting results.

F. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

G. Set, adjust, and aim adjustable fixtures at night. Repeat procedure until units provide illumination acceptable to the Owner.

3.7. 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.

3.8. DEMONSTRATION

A. Provide a minimum of four (4) hours of demonstration of luminaire operation.

B. 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.

3.9. LIGHT SOURCE REPLACEMENT AND PROVISION OF SPARE PARTS

A. At time of Substantial Completion, replace LED assemblies and electronic LED drivers in luminaires which are observed to be not functioning properly after Contractor's use and testing at the discretion of the Architect.

B. Provide stock or replacement components as specified in this Section Paragraph "Extra Materials".

END OF SECTION 265600

SECTION 27 05 00 – COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Telecommunications Room Build out

B. Pathways for Telecommunications Systems

C. Grounding and Bonding for Telecommunications

1.2 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.

1.3 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.

1.4 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 Room 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 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.

1.5 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 request 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 functionally 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 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.

1.6 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

2.1 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 panels 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. Each 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 .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 e[illegible] and proposed equipment. 30% growth capacity shall be provided in addition to deta[illegible] requirements.

5. Racks, cabinets and other termination equipment shall be properly s[illegible] flo[illegible] with appropriate anchors and bonded to Telecommunications Groundi[illegible] System.

6. Unit shall be similar to Ortronics OR-DCC422846-00002 or approv[illegible]equi[illegible]ent.

7. Provide (1) 8-port transient surge protection strip for ea[illegible] TR and [illegible]r rack/cabinet in the TER and TRs.

B. Cable Management

1. Horizontal Cable Management

a. Horizontal wire management panels [illegible]equire[illegible] for patch panels in certain racks. (See drawings for rack diagrams.)

b. Horizontal cable manage[illegible]ent shall occupy 1 or 2 rack units, as shown on T Drawings.

c. Similar to OR-MM6[illegible]F1[illegible] [illegible]proved equivalent

2. Vertical Cable Man[illegible]t

a. Vertical Ca[illegible]e manage[illegible]ent shall be provided for all racks. Provide 2 for each rack or cabin[illegible]

b. C[illegible]le ma[illegible]gement shall be – Ortronics OR-60400510, or approved equivalent.

C. Wire[illegible]esh Cable [illegible]y

1. Cablofil CF 12" X 2"

2. C[illegible]ofil CF 12" X 4"

3. Cablobil CF 18" x 2"

D. [illegible]dder-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
   d. Two locknuts shall be used on each box. One on the [illegible] on the exterior to adjust box/conduit height.
   e. Conduit shall not protrude into boxes beyond attachment flanges.

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 color 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. Large Capacity In-floor box
   a. Wiremold Evolution Series EFB6S with flush mounted cover.
2. Poke through
   a. Unit shall be similar to Wiremold Evolution 8AT Series with 5 gangs.

I. Distribution Backboard

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 PBB in the Telecommunications Equipment Room as shown on T Drawings.

b. Provide a SBB in every Telecommunications Room and distribution cabinet location as shown on T Drawings.

c. The telecom grounding and bonding system shall be bonded to the main electrical ground for the facility.

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 and cabinet.

PART 3 - EXECUTION

3.1 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.

3.2 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 SBB/PBB 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 connector protective bushing.

2. Sleeves through all fire rated structures shall have appropriate stop system.

END OF SECTION

SECTION 27 10 00 - STRUCTURED CABLING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Local Area Network (LAN) Cabling

B. CCTV System Structured Cabling

C. Telephone Cabling

D. Termination Equipment for Telecommunications

E. Faceplates and Outlets

1.2 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.

1.3 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.

1.4 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-[illegible]-I

x. Fibre Channel 100-SM-LC-[illegible]

xi. Fibre Channel [illegible]X-SN-I

xii. Fibre Chan[illegible]-L

xiii. Fib[illegible]MX-SN-I

xiv. [illegible]re Chan[illegible] 400-SM-LC-L

xv. Fi[illegible]el 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 cable 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 solid-bottom-type cable tray from corridor to distribution racks and termination fields in telecommunication rooms.

vii. Install "waterfall" device providing swing 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.

1.5 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, 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 Qualification: 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.

1.6 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 is 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.

1.7 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 covering 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

2.1 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 operational 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

2.2 J-HOOKS

A. Cooper B-Line BCH series 23 cm x 4.
1. Provide in sufficient quantity for 15% future expansion.
2. Installed no more than 5' apart.
3. Install in all areas without cable tray above false ceilings.

2.3 HORIZONTAL CABLES

A. Category 6 100 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 Data, Wireless and CCTV 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

2.4 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

2.5 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 P6E48
   3. Hubbell PCMGT 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 FSPSCDM6AQ
   2. Hubbell FSPSCQM6AQ
   3. Hubbell FSPSCDS6
   4. Hubbell FSPSCQS3
   5. Or approved equal from

a. Ortronics
b. Panduit
c. Systimax
d. Leviton

E. Fiber Connector
1. Hubbell FCSC900K50GM12 50/125um OM4 Aqua
2. Hubbell FCSC900K50GM12 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

2.6 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 HJ6xx (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

2.7 PATCH CORDS

A. Cat 6a UTP Copper Patch Cords
1. Hubbell HC6Axx03
2. Hubbell HC6Axx05
3. Hubbell HC6Axx07
4. Hubbell HC6Axx010
5. Hubbell HC6Axx15
6. Hubbell HC6Axx20
7. Hubbell HC6Axx25
8. Or approved equal from
   a. Ortronics
   b. Panduit
   c. Systimax
   d. Leviton

B. Cat 6 UTP Copper Patch Cords
1. Hubbell HC6xx03
2. Hubbell HC6xx05
3. Hubbell HC6xx07
4. Hubbell HC6xx010
5. Hubbell HC6xx15
6. Hubbell HC6xx20
7. Hubbell HC6xx25
8. Or approved equal from
   a. Ortronics
   b. Panduit
   c. Systimax
   d. Leviton

C. Fiber Patch Cords
1. Hitachi Singlemode
2. Or approved equal from
   a. Ortronics
   b. Panduit
   c. Systimax
   d. Leviton

PART 3 - EXECUTION

3.1 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 for all work and 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.

3.2 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 service.
   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.

3.3 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 recommend[ed] methods.
10. Tight 90-degree bends are unacceptable and use of plastic "cinch-type" tie-wrap[s] are not permitted, in order to prevent damage to cable jacket and compromise the cable electrical or optical characteristics.
11. Cable bundles shall be neatly routed with a service loop to provide [1]0 feet of slack at the cross-connect end and as noted in the T-drawings. Cable bundles s[hall] be secured using only black Velcro cable wraps.
12. 10 feet of service loop shall be provided in the ceiling at ea[ch] workst[ation]. Contractor shall not secure service loop in coils, but route in such a ma[nner] as to minimize EMI.
13. Wireless outlet locations

    a. Wireless locations shown on T-series drawi[ngs] shall be installed outside of a faceplate.

    b. Ceiling shall be marked and as-builts sha[ll] reflect location of all terminated ends and service loops as directed by CHO[ICE] DISTRICT personnel.

    c. Cable shall be terminated in a[n] RJ-[45] female jack and left with a service loop as described in T-series dra[wi]ngs. Cable shall be tested and documented per previous requirements.

    d. After completion [of] wi[re]ss site survey, outlet shall be re-terminated for connection to W[ire]less [Access] Point.

B. Determine allowable cable [pro]ximity to other electrical power sources of 480 Volts or less using TIA/EIA-56[8] "Cabling [Pa]thway Standard" for UTP cable separations from sources of EMI:

1. Minimum [se]paration [dis]tance from Power Source at 480 V or less:

	CONDI[TION]	< 2kVA	2-5 kV	> 5 kVA
a.	U[n]shielded power lines or electrical [eq]uipment in proximity to open or no[n]-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, 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, 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.
   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 TE with #3 AWG bonding backbone to TMGB per Telecommunications Grounding Diagram. It shall be left to licensed electrician to interconnect TMGB w to point of building ground. Contractor shall verify TMGB has been b ded t uilding ground before declaring completion.

F. Permanently identify all system components following ANSI/TIA-6 Administration Standard for Commercial Telecommunications Infrastructure" w identi ation format:
   1. Identification: Provide permanent identification labels for ets, face ates, patch panels, access panels and entrance facilities.
   2. Each individual cable shall be labeled on both end cable term ations regardless of cable intended use. Labels must be machine pri d with pe anent black ink on laminated white label material. Contractors must ck wit appropriate school district personnel for appropriate labeling sch e. T nded format and labeling material must be approved by school di t Tec ology Department before labeling begins.

3.4 TESTING

A. LAN
   1. Upon completion of work, all parts of the elecommunications installation shall be tested by the Telecom nica ons Contractor and demonstrated free of any defects. Preliminary testing d be p itted but shall not be accepted in lieu of obtaining final test results. Fina esults shall be accomplished by the use of proper test equipment for ste ing tested.
   2. Re-termina and re t any cables or pairs of cables failing end-to-end testing requireme . Replac any faulty cables/pairs or termination devices. Remove all defec e c es com etely from pathways.

B. As-Bui
   1. urate s-built drawings shall be provided in electronic and hard copy format.
      a. wings shall accurately show and describe all cable routing and equipment loc ion 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.

3.5 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 41 00 – AUDIO-VIDEO SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. This section and associated drawings define audio and video systems for the gymnasium, cafeterias, music room, conference, and culinary classroom spaces. The contractor shall provide all equipment, cables and components necessary for complete systems.

a. These systems shall be integrated with each other and function both separately and as a unit.

1.2 SYSTEM DESCRIPTION AND SUMMARY

A. Audio / Video Systems

1. Specialized Space A/V systems shall include audio and video input locations, signal processing and scaling, switching, mixing distribution and amplification to speakers and display devices. The system shall be capable of analog and digital signal formats and have lectern or wall mounted controllers.

2. Gymnasium A/V System shall include audio and video input locations, signal processing and scaling, switching, mixing distribution and amplification to speakers and display devices. The system shall be capable of analog and digital signal formats as well as zoning and zone combining. Wireless microphones and assistive listening devices shall be provided as part of the systems.

3. Auxiliary Gymnasium A/V Systems shall include audio input locations, signal processing, switching, mixing distribution and amplification to speakers. The system shall be capable of analog and digital formats as well as zoning and zone combining. Wireless microphones and assistive listening devices shall be provided as part of the systems.

4. Cafe A/V Systems shall include audio and video input locations, signal processing and scaling, switching, mixing distribution and amplification to speakers and display devices. The system shall be capable of analog and digital signal formats as well as zoning and zone combining. Wireless microphones and assistive listening devices shall be provided as part of the systems.

5. Music room multi-input, mixing and multi-loudspeaker system shall be provided. The equipment rack shall contain the audio equipment and allow for presets or live mixing if various inputs. Loudspeakers shall be provided and place as shown on the drawings. Clearly label and color code the master volume control for all functions. Wireless microphones and assistive listening devices shall be provided as part of the systems

6. Conference A/V Systems shall include audio and video cabling and input locations to speakers and display devices. The system shall be capable of analog and digital signal formats.

7. Classroom A/V Systems shall include audio and video cabling and input locations to speakers and display devices. The system shall be capable of analog and digital signal formats. Wireless microphones and assistive listening devices shall be provided as part of the systems

8. Culinary A/V Systems shall include audio and video cabling and input locations to speakers and display devices. The system shall be capable of analog and digital signal formats. Wireless microphones and assistive listening devices shall be provided as part of the systems

9. All stand-alone sound systems must have call override from the Intercom/PA system in the case of an emergency.

10. Hearing Assistance System - Provide a reinforcement system for the hearing impaired in the Gymnasium and Cafeteria. The hearing assistance system shall be an FM radio system that shall not limit operation to certain seats or areas of the room(s). Provide approximately 20-40 milliseconds of high-quality digital signal delay to help in the localization of the sound source.

B. Regulatory requirements

1. All work will conform to the National Electric Code and applicable local ordinances.

1.3 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 special 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. Digital and Analog Input Plates

b. Scalers

c. Processors

d. Mixers

e. Touch Panels

f. Controllers

g. Signal Extenders

h. Switchers

i. Display Devices

j. Input Sources

k. Sound coverage and pressure level diagram for each auxiliary sound system

l. Sound Amplifier

m. Sound Speakers

n. Sound Microphones

o. Sound Cabling and Wiring

p. Audio Visual cables and connectors

q. Communications outlets, faceplates, and accessories.

r. Wall outlets

s. Wire types

t. System wiring diagrams showing all connections

u. Shop Drawings including all equipment locations

v. Associated equipment specifications and cut sheets

w. 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 01, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual described in that Section.

1.4 As-builts

A. All systems must have as-built drawings provided in electronic CAD and hardcopy format that clearly show all system components, wiring schedules and system interconnections.

1.5 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 WCPS personnel. Any work found to be of inferior quality and/or workmanship shall be replaced and/or reworked until the approval of WCPS is obtained.

B. Qualifications

1. Installer

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.

1.6 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.

3. In addition, the primary manufacturer of the Networked Communications and Event Management System will offer a 5 year warranty on all items they supply.

1.7 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.

1.8 Operation And Maintenance Manuals

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

PART 2 - **PRODUCTS**

2.1 MANUFACTURERS

A. Acceptable manufacturers

1. The auxiliary sound systems are based on Biamp, Shure, [illegible] Listen, Crown, Lowell and other like reputable manufacturers.

a. Equipment substitutions must be submitted in writing to the design team for review and approval.

b. Any equipment not meeting the design criteria will be rejected at the contractor's expense.

2.2 MATERIALS

A. PRODUCT OVERVIEW.

2.3 AV Systems

A. Gymnasium

1. Controller

a. Extron IPL Pro 52 M

b. Extron RWM-P Junction Box

2. Control Processor

a. Extron IPL Pro S6

3. AV Switch

a. 8 Port PoE Gigabit Switch

4. AV Mixers / DSP

a. Biamp TesiraFORTE DAN AI

i. Include all required cards

b. Extron IN1608xi

5. Input Plates

a. BTX Custom as needed

b. Attero Tech un D610-BT

c. Extron DTP T HWP 4K 331 D

d. Extron DTP T DWP 4K 331 D

6. Amplifiers

a. Crown CDi 1000

b. QSC CMX 800Va

7. Loudspeakers

a. Community R.5-99TZ

b. Community R.6 Basshorn

8. Mounting Bracket

a. Community rigging

9. Shunt Relay

a. Bogen VAR1

10. Hearing Assistance

a. Listen LS-54-072 Kit

11. Equipment Rack

a. Lowell LER-3522

12. Door

a. Lowell LFD-35 (1)

13. Rack Shelf

a. Lowell US-214

14. Blank Panel

a. Lowell LE-193

15. Storage Drawer

a. Lowell UDEL-214 (1)

16. Line Level

a. RDL STACR-2 (1)

17. Power Supply

a. RDL PS-24AS (2)

18. Line Level Transformer

a. RDL TX-70A (1)

19. CD/Bluetooth Player

a. Denon DN-300Z

20. Wireless Mics

a. Shure ULXD124/58 (2)

21. Antenna

a. Shure UA844SWB (2)

22. Hand Held Mic

a. Shure SM58 (2)

23. 25’ Mic Cable

a. ProCo SMM25 (2)

24. Mic Stands

a. Ultimate MC-05B (2)

25. MPC Input

a. Whirlwind Isopod

26. Direct box

a. Whirlwind PCDI (1)

27. Power Sequencer

a. SurgeX SEQ

28. Projector

a. Epson L1070unl with

b. Coordinate exac ns wi distance and screen

c. Install in sc lift

29. Scissor lift

a. Draper X

b. Mini m 24” drop

30. Scre

a. Draper 16:10 Format 16’ X 10’ wall-mounted large electric tensioned drop-down screen

31. Cables

a. 16/2 AWG Speaker Wire

b. XLR Mic Cables

c. Extron XTP DTP Cat 6 UTP

d. 18/2 AWG Control Cable

B. Auxiliary Gymnasium

1. Controller

a. Biamp TEC-1s

2. AV Switch

a. 8 Port PoE Gigabit Switch

3. Mixer / DSP
   a. Biamp TesiraFORTE DAN AI
   b. Include all required cards
4. XLR Input Plates
   a. BTX Custom as needed
   b. AtteroTech unD610-BT
5. Amplifier
   a. QSC RMX 1450a
6. Loudspeakers
   a. EV SX100+
7. Mounting Bracket
   a. EV MB
8. Shunt Relay
   a. Bogen VAR1
9. Controller
   a. Crestron MC4 with ANT- XT- Antenna and TSR-310 Remote
10. Hearing Assistance
    a. Listen L Kit
11. Equipment ck
    a. owell L
12. L
    a. ell LFD-35 (1)
13. Rack Shelf
    a. Lowell US-214
14. Blank Panel
    a. Lowell LE-193
15. Storage Drawer
    a. Lowell UDEL-214 (1)
16. Line Level
    a. RDL STACR-2
17. Power Supply
    a. RDL PS-24AS

18. Line Level Transformer
    a. RDL TX-70A
19. CD/Bluetooth Player
    a. Tascam CD-200BT
20. Wireless Mics
    a. Shure SLXD128/85
21. Antenna
    a. Shure UA844SWB (2)
22. Hand Held Mic
    a. Shure SM58 (2)
23. 25’ Mic Cable
    a. ProCo SMM25 (2)
24. Mic Stands
    a. Ultimate MC-05B (2)
25. MPC Input
    a. Whirlwind Isopod
26. Direct box
    a. Whirlwind PCDI (
27. Power Sequen
    a. Surge SEQ 2RU
28. Cabl
    a. 16 AWG Speaker Wire
    b. Mic Cables
    c. Cat 6 UTP

C. sic Room Sound Systems

1. Controller
    a. Biamp TEC-1s
2. Mixer / DSP
    a. ART MX622 Mixer
    b. Biamp Tesiraforte DAN AI
3. XLR/3.5
    a. BTX Custom Plate
4. Loudspeakers

a. Ev Evid 6.2

5. Amplifier
   a. QSC GX3
6. Assistive Listening
   a. Listen LS-54-072 Kit
7. Wireless Mics
   a. Shure ULXS24/58
8. AV Switch
   a. 8 Port PoE Gigabit Switch
9. CD/Bluetooth Player
   a. Denon DN-300z
10. SD Recorder
    a. Tascam SS-R200
11. Overhead Mic
    a. Shure MX202W/C
12. Rack
    a. Lowell LWR-2119
13. Shunt Relay
    a. Atlas A
14. DPDT Roc
    a. DL-A
15. e
    a. AMS-UF1
16. Filler Plates
    a. RDL-AMS-FP1
17. 19” Rack Mount for 3 Rack UP Series
    a. RDL RU-RA3

. Cafeteria Sound and Video Equipment

1. Controller
   a. Extron IPL Pro S6
2. Keypad Controller
   a. Extron TLP Pro 525M
   b. RWM-1 Junction Box

3. Mixer / DSP
    a. Biamp TesiraFORTE DAN AI
4. Input Plates
    a. BTX Custom Plates
    b. Attero Tech unD610-BT
5. Amplifier
    a. Crown XLC 21300
    b. QSC RMX 1450a
6. CD/Bluetooth Player
    a. CD-200BT
7. AV Switch
    a. 8 Port PoE Gigabit Switch
8. Loudspeakers
    a. JBL CT1000 with mounting brack[illegible]s.
    b. Biamp V2-215S subwoofer with [illegible]ing br[illegible]kets.
9. Stage Monitor
    a. EVI ZX1 (2)
10. Hearing Assistance Sys[illegible]
    a. Listen L[illegible])
11. Projector
    a. [illegible]pson L[illegible]E with ELPLM111 Lens
12. S[illegible]or [illegible]t
    a. [illegible]er SLX
13. Equipment Cabinet
    a. Middle Atlantic SR-46-28 swing open wall cabinet
    b. Vented Front door
14. Rack Shelf
    a. Middle Atlantic D3LK
15. Hinged Panel Mount
    a. Middle Atlantic HPM-4
16. Lid
    a. Middle Atlantic HPM-LID
17. 25’ Mic Cables

a. ProCo SMM25 (4)

18. 50’ Mic Cables
    a. ProCo SMM50 (2)
19. 25’ Patch Cable
    a. ProCo S12NN-25 (2)
20. 24 VDC Power Supply
    a. As needed
21. Wireless Mics
    a. SLXD124/58
22. Hand Held Mic
    a. Shure SM58 (4)
23. Mic Stands
    a. Ultimate MC-05B (2)
24. MP3 Input
    a. Whirlwind Isopod (1)
25. DI Box
    a. Whirlwind IMP2 (2
26. Direct Box
    a. Whirlwi 1)
27. Power Sequ cer
    a. urgeX
28. A Mi
    a. n IN1608xi
29. Bluetooth / Line Level Input
    a. Attero Tech unD610-BT
30. Signal Extenders
    a. Extron DTP HDMI Series
31. Cables
    a. HDMI
    b. VGA
    c. 3.5 MM
    d. Extron XTP Cables

E. Conference AV Equipment

1. Extron Pro HDMI Cable 50’
2. Kramer 65 USB Cable 65’
3. 75” Interactive Display

F. Classroom AV Equipment

1. Extron Pro HDMI Cable 50’
2. Kramer 65 USB Cable 65’
3. 75” Interactive Display
4. Audio Enhancement Sentinel System
   a. CA-60A Amplifier
   b. XD Teacher Microphone
   c. XD Receiver
   d. CS-12 Ceiling Speakers
   e. WS-09 Wall Speakers
   f. FS-17 Flat Speakers

G. Culinary Demo AV System

1. Extron Pro HDMI Cables (proper lengths)
2. RS-232 Control Cable
3. Extron HDMI DA6 H[illegible]K
4. Extron IPCP 50[illegible]roller
5. Extron TLP [illegible]ro 525M
6. Legr[illegible] Rob[illegible]ot 12[illegible] Camera
7. [illegible]rand R[illegible]ooshot 12E QDVI
8. Audi[illegible]nhancement MS-400 System
9. Audio Enhancement CS-12 Ceiling Speakers
10. Samsung RU71000 43” LED Display with RS-232C
11. Chief CB-22 Ceiling Enclosure

PART 3 - [illegible]XECUTION

E[illegible]mination

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.

3.2 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.

3.3 Installation

A. Provide and install all components required to install complete intercom/PA/master clock system, including (but is not limited to) wire, connectors, patch panels, call switches, speakers, etc…

B. Secure all horizontal cables within building 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 trays 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 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 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 room rough into hallway (minimum of 2) with protective insulating bushings, cable spill over specially designed cable tray sections, with appropriate firestop material.

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.

3.4 Testing

A. Audio Visual Equipment

1. The contractor shall test all equipment for proper signal transmission based on manufacturer standards.

2. The contractor shall record remove any cable that does not meet manufacturer standards and replace it with a correctly functioning cable.

3. The contractor shall demonstrate that the installed cables meet manufacturer standards for signal transmission prior to the job being considered complete.

B. Sound Equipment

1. The contractor shall test all aspects of the sound system 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. Microphones shall be demonstrated to work as intended by the manufacturer.

3.5 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. 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 Manufacturer's Warranty Application.

END OF SECTION

SECTION 27 41 16 - SMALL AV SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Classroom AV Systems
2. Conference Room AV Systems
3. Small Office AV Systems

1.2 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 amplifier/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.

1.3 SYSTEM DESCRIPTION

A. Design Requirements

1. Classroom AV system displaying various AV content from a source device wired and wirelessly.
2. Classroom Sound distribution through a pendent style portable microphone and at least one hand held microphone per learning area.
3. 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.
4. All stand-alone sound systems must have call override from the Intercom/PA system in the case of an emergency.

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)

1.4 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 Statewide 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. Electronic displays

2. AV Cabling

3. Sound Amplifier

4. Sound Speakers

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.

1.5 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 3 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 and 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.

1.6 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

2.1 MATERIALS – ALL MATERIALS SHALL BE NEW AND UNUSED

A. Acceptable Products

1. Classroom Sound Reinforcement System.

a. Lightspeed 955 Access System (mounted to wall, coordinate with architect and owner prior to installation)

b. Audio Enhancement

B. 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 lay-in ceilings.

C. Classroom Sound Equipment (Lightspeed 955 Access)

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 sound.

4. Speakers

a. Ceiling Speaker (four speakers for rooms of 1600 sq. ft. or less)

b. Description: 2-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)

2.2 CLASSROOM / CONFERENCE / COLLABORATION A/V CABLING

A. The "L" and "M" & "L1" and "M1" 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. Extron Pro Cable with equalizer – Minimum 50. Increase length as needed.
   b. Tripplite USB-A M/F (U330-20M)
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.

2.3 ELECTRONIC DISPLAYS

A. 75" Interactive Display
   1. Smart 7275 Display

B. 65" Interactive Display
   1. Smart 6265 Display

PART 3 - EXECUTION

3.1 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.

   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.

3.2 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.

3.3 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 loading. 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 signal transmission requirements

6. Do not support cables from ceiling 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	3 in.	6 in.	12 in.
b. Power lines enclosed in a grounded	3 in.	6 in.	12 in.

	metal conduit (or equivalent shielding) in proximity to grounded metal conduit pathway			
c.	Transformers & Elec. Motors	40 in.	40 in.	40 in.
d.	Fluorescent Lighting	12 in.	12 in.	12 in.

C. Install all cable in accordance with National, state and local codes and TIA/EIA Standards, a... BICSI methods.

1. Follow manufacturer's guidelines and requirements for all cable termina...n.

D. Permanently identify all system components following TIA/EIA-606A "Administrat... Standard for Commercial Telecommunications Infrastructure" with identification f...mat:

1. Identification: Provide permanent identification labels for outlets, ...ceplates and cables.

2. Each individual cable shall be labeled on both ends of c...le te...inati... regardless of cable intended use. Labels must be machine printed ...h perma...nt black ink on laminated white label material. Contractors must check with app...priate school district personnel for appropriate labeling scheme. The in...ded ...r and labeling material must be approved by the school district Technolo... Depa...ent b...fore labeling begins.

3.4 TESTING

A. Systems

1. The contractor shall test all a... of the Systems once it is installed and demonstrate these functions to the own... of ow...er's representative.

a. Speaker levels shall b... ...ied to function individually and as a unit.

b. Control of t... syste... shall ...e shown to control all aspects of the systems.

c. Levels sha...e set fo... ...ll outputs.

d. M...rophon...s shall be demonstrated to work as intended by the manufacturer.

3.5 AS-BUILTS

A. As-b...ts shall be pr...ded by the contractor in hardcopy and electronic CAD format prior to co...tion.

B. As-built... contractor must include parts lists and wiring diagrams that clearly indicate all ...ipment, locations, wiring and connections.

C. Ow...er's manuals shall be supplied as part of the as-built documentation.

3.6 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.

3.7 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 41 18 AUDITORIUM AUDIO & VIDEO SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work specified in this section.

1.2 RELATED WORK AND REQUIREMENTS

A. Section 26 00 00

1.3 SCOPE OF WORK

A. Definitions: For this project, the following entities are referenced:

1. Owner: Dover Central School District, Dover
2. Architect: KCBA Architects, Hatfield, PA
3. Theatre Consultant: Scheu Consulting Services, Inc., Fayetteville, NY

B. This section requires the fabrication, furnishing, delivery, installation, testing of the sound and video systems, equalization of the sound system and programing of the control systems as indicated on the drawings and specified herein.

C. The contractor shall provide all materials, equipment, procedures, labor, tools, scaffolds, and incidentals necessary to the completion of work.

D. The contractor shall provide a professional quality, complete and properly operating system in every respect and detail.

E. The contractor shall examine the plans in detail to familiarize him with the scope of the work.

F. The contractor shall assume full responsibility for a complete operating installation, in the required location, in accordance with the contract documents.

G. The contractor shall provide all necessary specialty equipment for the complete sound and video system installation as specified herein.

H. The contractor shall provide all necessary specialty equipment for the complete sound and video system as shown on the drawings.

I. Any errors, omissions, or ambiguities found in these documents do not relieve the contractor from the responsibility of providing all items necessary for complete, safe, fully functional systems. Any errors, omissions, or ambiguities shall be brought to the attention of the Architect/Engineer of Record, Owner, and/or Theater Consultant for clarification.

J. The drawings and specification when taken together communicate the design intent of the system. The contractor is responsible for all engineering, procedures, drawings, equipment, material, means and methods, and contract administration necessary to fully and completely provide and install the system contemplated by these documents

K. Anything shown on the drawings or included in this specification shall be considered as part of both documents.

L. No changes will be allowed for any issue that could have been known at the time of bid. This includes but is not limited to discontinued products.

M. The contractor is solely responsible for meeting all codes and regulations and for the complete code compliance of the finished system.

N. The contractor shall employ the most current best standard practices for all aspects of wo

O. The contractor acknowledges that the consultants' opinion is final.

P. The systems shall conform to all applicable code requirements and shall b provided nd installed in conformance to industry standards of operation and practices. All materi arrangem nts, and procedures shall comply with applicable code requirements, allowing the e ser to arrange and operate a safe assembly and working environment for audience a per

Q. Control system programming in a manner that meets all the o r's need d request in terms of function and usability. Contractor shall provide:

1. Crestron source code
2. Crestron assembled installed code
3. Crestron control pages must be controlla via nPa
4. Crestron control: in addition to the touch pa provid both executable and web-based x-panel interfaces

R. DSP programming, system tunin and c plete configuration of all components.

S. Mounting and attachments of a ers, projectors, screens and equipment unless specifically indicated otherwise.

T. Register all wireles nic freque es in the "White Space" data base.

U. Coordinate f y with cal contractor.

1.4 WORK INCLUD

A. Without restricting volume or generality of above "Scope", work to be performed under this section shall include, but is not limited to, the furnishing and installation of the following:

1. mplete AV system in the Auditorium

a) Left and Right main line arrays with subwoofers
b) Portable FOH mixing console and portable FOH rack with connection in the control booth and seating area
c) Combination panels with system connection points
d) Small event system
e) Wireless microphone systems
f) Technical production intercom system
g) Assisted listening system
h) Video projector and screen
i) Video distribution and control systems
j) Audio and video show relay systems

k) Portable equipment package

2. Portable sound system in the Blackbox

B. The contractor shall examine the plans in detail to familiarize himself with the scope of work.

C. The sound contractor will provide necessary millwork, enclosures, baffles, grille cloth, wall pl... an... any other item furnished under this contract not specifically noted otherwise herein or on the draw...gs in a manner and color as approved by the owner.

D. The contractor shall provide the required shop drawings.

E. The contractor shall provide all the necessary specialty equipment for the co... syste... stallation as specified herein, and shown on the drawings.

F. The contractor shall coordinate the system conduit and device locations wit... Div...ion 26 Contractor.

G. The contractor shall deliver to the job site, and coordinate the ...allation ... the specialty equipment with the Division 26 Contractor.

H. The contractor shall provide, install and terminate ...re.

I. The contractor shall provide and install all sy... d...ces.

J. The contractor shall provide the system manuals.

K. The contractor shall provide the ...stem ...rranty.

L. It is the contractor's responsibil... ensure that the system and all of the system components, fixtures, equipment, devices, wi... ...inati... field assemblies (including custom assemblies), etc pass all required inspections ... the loc... auth...ty having jurisdiction.

M. The contractor shall ...ocure of... required permits.

N. Power:

1. Provide ...ox in the top of each rack for the electrical contractor to "make up" to.
2. Provide po... strips, power outlet boxes, internal rack wiring and everything necessary to power up all rack equipment.
Provide LynTec power sequencing panelboard.

O. Othe... equirements:

1. All RJ45 jacks and portable cables shall be color coded according to function.
2. All RJ45 portable cable shall be heavy duty service type – Wireworks TacCat6 or equal.
3. All RJ45 jacks shall be Nuetrik EtherCON.

1.5 WORK NOT INCLUDED

A. The following items of work, if required, are included in other sections and must be reviewed by the sound contractor for impact on this work:

1. Necessary conduit and raceway runs.

2. Stage flooring.
3. Theatrical stage lighting and electrical connections, electrical contractor supplied junction and back boxes, wiring to power sources, and wiring to all other electrically powered devices.
4. Front of house catwalks.

1.6 CONTRACTOR'S QUALIFICATIONS

A. Only qualified contractors shall be used.

B. The work of this section will be contracted to a single firm, referred to as the contractor.

C. The contractor shall be a sound systems contractor who regularly engages in the furnishing, installation and servicing of professional sound systems of similar nature, size, scope and complexity to that contemplated by this specification. The contractor shall have done so for a period of not less than five years preceding the bid date.

D. The sound contractor shall have maintained for the five years preceding the bid date, a suitably staffed and equipped service organization which has continuously offered maintenance and repair services for systems of the nature, size, scope and complexity to that contemplated by this specification.

E. The contractor must not have any existing liens filed against the project.

F. The contractor shall be licensed and insured.

G. The contractor shall be a factory authorized dealer for the major system components:

1. Mixing console
2. Speakers
3. Amplifiers
4. Signal processors
5. Control system
6. Video projector
7. Wireless microphones

H. The contractor shall demonstrate to the satisfaction of the owner, through exhibits presented with his bid, that the proposed contractor is qualified and has a history of successful installations by providing the following:

1. Statement of current company capabilities and ownership.
2. Statement of company history. Include a breakdown by percentage of gross sales of all business activities the contractor is involved in for each of the last 5 years (e.g. system installation = 30%, retail sales = 40%, equipment rentals = 20%, design and other professional services = 10%, etc).

3. Previous experience: Provide a list of four installations of the type and size contemplated by these specifications, currently in use as originally installed, in which a theatre / system consultant was involved, completed in the last 5 years and the following information regarding each installations:

4. Name and address of each installation facility.

a) Facility owner and telephone number.
b) Name, address, and phone number of a person regularly employed by the owner, who is familiar with the operation of the systems and who has no connection or business connections with the contractor except as the contractor shall fully disclose

c) Name, address, and phone number of the theatre / system consultant, along with the names of all the consultant's personal directly involved.
d) System shop drawing - These will be returned if the contractor provides a call tag or return postage.
e) Owner's manual drawing - These will be returned if the contractor provides a call tag or return postage.
f) System as-built drawings drawing - These will be returned if the contractor provides a call tag or return postage.
g) List of contractors personal involved with each person's responsibility on the project.
h) Name, address and phone number of the general contractor, along with the names of all key GC personal directly involved.
i) Name address and phone number of the electrical contractor, along with the names of all key EC personal directly involved.
j) Adequate plant, equipment, test facilities and inventory to pursue the work properly and in a timely fashion.
k) Sufficient staff and technical experience

5. Key Personnel: For each of the key personnel listed below include the individual's name, title, and number of continuous years of service to contractor. Include a biography detailing industry experience, and role within organization (include only full-time/regular staff employees; not independent contractor, freelance, or temporary positions). List all industry certifications held, training courses attended, and continuing education credits including dates of attendance. List recently completed projects, scope of project and completion dates.

   a) Project Manager - Must have B.S. degree in Science or Engineering or 20 years of experience + advanced AV system technical training. Must also a very high proficient in industry specific test and measurement equipment, techniques and practices.
   b) Senior Technician – Must have 10 years of experience and completed Syn-Aud-Con or equal training.
   c) Service Manager
   d) Other Department Staff – Include size of staff, and experience of each staff member.

6. Replacement and Spare Parts Inventory – Provide detailed list of primary replacement parts, components, and spares typically held in inventory.
7. Test Equipment and Physical Plant – Include an inventory of all test facility equipment owned and used regularly by the Service Department. Provide description of physical plant and space utilization.
8. Copies of business and professional licenses and insurance certificates.

PART 2 PRODUCTS

2.1 ALTERNATES

A. In no case will equipment or materials of lesser design or workmanship be acceptable. Only those materials and equipment listed in this specification will be considered unless prior approval is sought and received.

B. Substitutions: When a specific piece of equipment specified has been discontinued and/or replaced by a new model, substitution will be acceptable when:

   1. Submission of complete data on the new model or substitute has been approved by the owner prior to equipment acquisition.

2. Substitute equipment or the replacement of rejected equipment shall be at the sole expense of the sound contractor.

C. Should the contractor proposed and receive approval for the use of alternative wire and cable which requires additional conduit, the contractor will be solely responsible for the installation of such conduit.

2.1 GENERAL REQUIREMENTS

A. The major items of equipment shall be furnished in the quantity as shown by the audio diagrams on the drawings and the quantity as specified herein.

B. When documents list several acceptable manufacturers for a particular item of equipment, more than one of which is to be provided, the sound contractor shall supply all of the similar items of equipment from one manufacturer.

C. Any item of equipment or hardware that may not be specifically shown on the drawings or specified herein but required for proper sound system operation or installation shall be furnished and installed and be of the highest quality available.

D. The performance of all equipment must meet the most recently published manufacture's data sheet

E. Provide all power supplies, POE injectors, rack power distribution, power cabling and related equipment.

F. Provide all software, drivers, and related elements.

1. Shure Wireless Work Bench
2. DSP setup / editor
3. Yamaha StageMix App
4. Yamaha console editor
5. Dante controller software
6. Amp control software
7. Crestron source code
8. Crestron assembled installed code
9. Crestron control pages must be controllable via an iPad
10. Crestron control: in addition to the touch panel, provide both executable and web-based x-panel interfaces
11. All others as required

G. The system has been engineered and coordinated to a very high standard. If alternates are not listed in the equipment list below there are no known equals.

H. Provide all equipment in the types and quantities shown on the contract drawings. There are no known equals to the equipment types shown

I. Provide all equipment in the types listed below and in the quantities as shown on the contract drawings:

1. LGT-2: Local Control Light

a) Dailight 557 Series red LED panel mount indicator light with voltage determined by DSP logic output.

2. SWT-2: Local Control Switch

    a) SPST MON panel mount push button switch

J. Backboxes and Enclosures: Furnish to the electrical contractor all specialty backboxes and enclosure required See the electrical device location drawings, system conduit rises and symbol key for types a quantities required.

1. CMBP = Whirlwind black powder coated surface mount 12x12x6 backbox with eit Whirlwi WFS flush mount wall frame + custom panel or Whirlwind WFS surface mount wal me custom panel. Equal Wireworks Guardian Panel Mounts + custom panels will ccep
2. ICSS = backbox for Clear-Com KB-701 speaker station
3. SJIP = SSRC PM series 1 gang overhung outlet box with custom face pl

K. Panels: All panels are made of 1/8" thick Aluminum plate, brushed anod black an sealed. All controls and connectors will have engraved labels. The minimum allowable el siz s 1/8"s. All labels will be back filled with white paint. All connectors are mo h m hardware. All panel layouts and labels must be submitted and approved prio construc on, the panels shown in the drawings are typical only.

L. Microphone Receptacles: The above general requirements panel ply to the construction of Microphone Receptacles as well. See the contract ings f uantity and type required.

M. Intercom Receptacles: The above general req mer for nels apply to the construction of Intercom Receptacles as well. See the contract drawings f quanti and type required.

N. Speaker Receptacles: The above ge requirements for panels apply to the construction of Speaker Receptacles as well. See the co ct d wings for quantity and type required.

O. Custom panels: See drawings fo red components.

P. Connectors:

1. All XLR cable nectors Neutrik “XX” series, black bodies, and silver contacts unless otherwi ndicat
2. All X R chass connectors are Neutrik “DLX” series, black bodies and silver contacts unless othe e i cated.
3. 6 pin X connectors for intercom must be “Switchcraft compatible”

    a) Six pix chassis mount male connector = Neutrik NC6MSD-L-1

4. All RJ45 plugs and jacks are Neutrik EtherCON CAT6A
5. plugs and jacks shall be color coded with sealing covers / rings by function.
6. All speaker cable connectors are Neutrik SpeakON series.
7. All RCA chassis connectors are Neutrik D-shaped housing, black chrome bodies, solder tabs with white / red isolation washers for stereo left right.
8. All BNC chassis connectors are Neutrik NBB75DFIB-P (isolated, feed through, D-shape, black housing, protruding version). Provide color coded (by function) rubber sealing cover.
9. All F type chassis connectors are Ace Backstage model C-25104 isolated feed through F type connector mounted in black plastic universal D size black plastic.

Q. System Wire: All wiring in a conduit, where the conduit is located in the slab or on grade, must be rated for wet location. Where West Penn Wire part numbers are specified, equivalents by Belden will be approved provided no change in conduit size is required. Where Belden part numbers are specified, equivalents by West Penn Wire will be approved provided no change in conduit size is required.

1. All low Z speaker runs and all monitor / effects speaker receptacles:

    a) Wire enclosed in conduit, racks, or speaker enclosures – twisted pairs of 10 A.W.G. THWN
    b) Wire enclosed in conduit; where the conduit is not in a wet location, racks, speaker enclosures - twisted pairs of 10 A.W.G. THWN
    c) Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – Whirlwind W12/4

2. All 70 volt speakers, volume controls, priority attenuators, priority attenuator relays:

    a) Wire enclosed in conduit; where the conduit is in a wet location - West Penn Wire AQC 225
    b) Wire enclosed in conduit; where the conduit is not in a wet location, racks, speaker enclosures - West Penn Wire 225
    c) Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – Whirlwind W16GA

3. All mic, line, and DC signaling:

    a) Wire enclosed in conduit; where the conduit is in a wet location – Belden 5500F1 or West Penn Wire AQC 291
    b) Wire enclosed in conduit; where the conduit is not in a wet location, and racks – West Penn Wire 291
    c) Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – Whirlwind W1192A-BK Star Quad

4. All intercom:

    a) Wire enclosed in conduit; where the conduit is in a wet location - Belden 5300F1 + an additional green with yellow strip 12 A.W.G. THWN wire or West Penn Wire AQC 293 + an additional green with yellow strip 12 A.W.G. THWN wire.
    b) Wire enclosed in conduit; where the conduit is not in a wet location, and racks – West Penn Wire 293 + an additional green with yellow strip 12 A.W.G. THWN wire.
    c) The additional 12 A.W.G. THWN wire shall be connected in parallel with the drain wire of the shielded twisted pair cable.

5. All AES/EBU:

    a) Wire enclosed in conduit; where the conduit is not in a wet location, and racks - West Penn DA24
    b) Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – Whirlwind W1800F

6. All Dante and Control Ethernet CAT6A:

    a) Wire enclosed in conduit; where the conduit is in a wet location - Belden OSP6AU
    b) Wire enclosed in conduit; where the conduit is not in a wet location, and racks – Belden 10GX32
    c) Wire not enclosed in conduit or racks, service type cables, connection jumpers - Wireworks TacCat6
    d) Patchbay cables - Belden 10GX32

7. ALS transmitter antenna RG58 50Ω:

    a) Wire enclosed in conduit; where the conduit is in a wet location - Belden 7808WB

b) Wire enclosed in conduit; where the conduit is not in a wet location, and racks – Belden 7807R
c) Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – Belden 7807R

8. Wireless microphone antenna RG8 50Ω:

a) Wire enclosed in conduit; where the conduit is in a wet location - Belden 7810WB
b) Wire enclosed in conduit; where the conduit is not in a wet location, and racks – Belden 7810A
c) Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – Belden 7810A

9. Analog video and all SDI video RG11 75Ω:

a) Wire enclosed in conduit; where the conduit is in a wet location - Liberty AV Solutions RG11-BC-CATV-DB
b) Wire enclosed in conduit; where the conduit is not in a wet location, and racks – Belden 4731R
c) Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – Belden 4694F

10. Modulated RF TV distribution RG6 75Ω:

a) Wire enclosed in conduit; where the conduit is in a wet location – West Penn Wire AQC806
b) Wire enclosed in conduit; where the conduit is not in a wet location, and racks – West Penn Wire 806
c) Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – West Penn Wire 806

11. HDMI:

a) Wire enclosed in conduit; where the conduit is not in a wet location, and racks - Extron HDMI Ultra Series
b) Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables - Extron HDMI Ultra Series

12. Crestron DM

a) Wire enclosed in conduit; where the conduit is in a wet location - consult Crestron
b) Wire enclosed in conduit; where the conduit is not in a wet location, and racks – Crestron DM-CBL-ULTRA-NP
c) Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – Crestron DM-CBL-ULTRA-PC

F. Internal Rack Power Wiring:

1. Provide all power wiring, devices, hardware, receptacles, etc. as required to power wall equipment within each rack.
2. Provide a junction box located at the top of the rack for connection to circuiting by the electrical contractor.
3. Provide power cables for all portable racks

S. Power Sequencing Panel Board

1. Provide to the electrical contractor for installation the flowing Lyntec Power Sequencing Panel Board:

    a) Model RCP 341 41/MBR-20 + SGX20-10
    b) Provide 125A main breaker
    c) Provide 20A, 30A, motorized, single pole, two pole, and standard breakers as indicated on electrical panel schedule.

T. Portable Equipment:

1. Show Monitor Mic: Mount a Shure SM87A from the roof trusses pointed toward the stage. This is a permanent installation and will require a custom assembly of mic mounting hardware. Typically a mounting flange with a small boom arm will be required to position the mic out into the room and rigidly hold it in position. Fishing line of other similar methods will not be accepted.
2. Mixing Console Accessories:

    a) 2 @ LED console gooseneck lamps
    b) Dust cover

3. Assisted Listening

    a) 30 @ Listen Technologies model LR-520 advanced intelligent DSP RF receiver
    b) 30 @ Listen Technologies model LA-401 universal ear speaker
    c) 10 @ Listen Technologies model LA-430 intelligent ear phone / neck loop lanyard
    d) 3 @ Listen Technologies model LA-380 intelligent 12-unit charging / carrying case
    e) 3 @ Listen Technologies model LA-303 multilingual assistive listening notification sign
    f) 30 @ Listen Technologies model LA-365 replacement rechargeable Li-Ion battery
    g) 3 @ Listen Technologies model LA-381 intelligent 12-unit charging tray
    h) 1 @ Listen Technologies model LA-202 LE venue awareness kit

4. Wireless Microphones

    a) 16 @ Shure ULXD2/B handheld transmitter with Beta 58 head. Include a SB900A lithium-ion rechargeable battery pack and standard accessories with each transmitter
    b) 16 @ Shure ULXD1 belt-pack transmitter. Include a Countryman H6 headset microphone with matching connector, a SB900A lithium-ion rechargeable battery pack, and standard accessories with each transmitter
    c) 16 @ Shure SB900A rechargeable lithium-ion batteries for spares
    d) 4 @ Shure SBC200-US dual docking recharging station with power supply
    e) 12 @ Shure SBC200 dual docking recharging station
    f) 2 @ Shure SBC800 8-up battery charger

5. Microphones. Provide a mic clip for each mic.

    a) 6 @ Shure SM-58
    b) 6 @ Shure SM-57
    c) 1 @ Countryman ISOMAX 4RF (M4HP5RF18EB) + AT8416 shockmount
    d) 2 @ Audio Technica 4040.
    e) 4 @ Audio Technica 4041.
    f) 1 @ CT Audio; C-Ducer CP Series CSP/8P.
    g) 5 @ Crown PCC160.
    h) 1 @ Countryman Type 85 Direct Box with set of 6’ patch cables.
    i) 1 @ Emtech Electronics, Inc. Model EJ-10 multi-input adapter box.
    j) 1 @ Whirlwind PCDI
    k) 6 @ Audio Technica U853R hanging mics

6. Microphone Stands & Accessories.

    a) 12 @ K&M KM210/91 black, mic stand w/boom
    b) 18 @ Atlas Sound MS12CE

7. Intercom Belt Packs.

    a) 5 @ Clear-Com RS-701.
    b) 2 @ Clear-Com RS-702

8. Intercom Single Muff Headset.

    a) 5 @ Clear-Com CC-300

9. Intercom Dual Muff Headset

    a) 2 @ Clear-Com CC-400

10. Intercom Cable, 6 pin XLR

    a) 2 @ 25 feet – Clear-Com IC-25/6
    b) 2 Clear-Com YC-36

11. Mic Cables: Whirlwind MKQ series in bl

    a) 12 @ 10 feet
    b) 24 @ 20 feet.
    c) 18 @ 30 feet.
    d) 6 @ 50 feet.
    e) 6 @ 100 feet.

12. Speaker Cables

    a) 4 @ Whirlwind NL-4-
    b) 4 @ Whirlwind [illegible]25

13. Patch Cables and Adapters - Audio

    a) 8 @ Neutrik NL4MM.
    b) 2 @ Switchcraft 389.
    c) 2 @ Switchcraft 390
    d) 2 @ Switchcraft 387A
    e) 2 @ Switchcraft 386A
    f) 2 @ Switchcraft 384A
    g) 2 @ Switchcraft 383A
    h) 1 @ Liberty AV Solutions DL-ARDA

14. Monitor and Portable Speakers.

    a) 4 @ Electro-Voice ZX3 w/ stand sockets
    b) 4 @ Galaxy Hot Spots with volume controls, stand yokes, and 2 NL4 connectors
    c) 6 @ Ultimate Support TS-90B speaker stands

15. Headphones.

a) 1 @ Sony MDR-7506

PART 3 EXECUTION

3.0 SUBMITTALS – The following submittals are required.

A. Within thirty days of the bid award and prior to beginning work, prepare and submit shop drawings and product data cut sheets to the architect for approval.

B. All of the following must be submitted at the same time

1. Shop Drawings: Complete shop drawings details and complete on all phases of installation including a minimum of:

a) Device location plan drawing(s)

1) Location of all devices
2) Confirm box type – surface or flush – as acceptable and constructible based on box depth and wall construction
3) Confirm color of all surface mount boxes

b) Control booth layout – plan, section and elevation drawings showing:

1) All equipment
2) All connection plates
3) Panduit wire duct if required
4) Free cable routing and required cable pass throughs / grommets
5) Conduit
6) Junction boxes

c) System wiring diagrams

1) Show remote ID and other setup info
2) Show wireless frequency coordination
3) Show IP address management
Show RF levels on TV distribution system
5) Show EDID information and management
6) Make and model of all equipment
7) All connection points on each piece of equipment
8) All wire types
9) All connector types
10) All cable labels

d) Rack drawings

1) Elevations showing all equipment labels
2) Section showing all equipment depth and rack rail locations
3) Power details

e) Details of all connection plates and custom panels including connector make and model.
f) Mounting and rigging details for all equipment.
g) Scale drawings showing the projector, the screen, the throw distance and all lens calculations in plan, front elevation, and section. Include all relevant architectural and stage rigging drawing details.

h) Mountings and Attachments: Scale plan, section and elevations drawings of all proposed enclosures and speaker mounting or rigging weighing more than ten pounds. All mountings and attachments must be approved and stamped by an engineer licensed in Delaware prior to the beginning of the installation.

2. Materials and Equipment submittal package:

a) A complete list of all materials and equipment to be furnished
b) Catalog cuts for all materials equipment

1) These must contain full information on dimensions, construction, application, etc. to permit proper evaluation.

c) Catalog cuts must be properly identified as to their intended use and any options or variations must be clearly marked.
d) The contractor is to confirm equipment availability at time of submittal. It is assumed that all equipment submitted on is and will be available
e) Color selection samples of devices for Architect's selection.

3. Test Equipment: The sound contractor will submit to the owner a list of test equipment to be used to test, equalize and demonstrate the final installation.

C. Schedule: Prior to the commencement of the installation work, the sound contractor shall submit for approval, to the owner, an outline of a proposed commencement and completion schedule and project requirements.

D. Variations: Any deviation from what is specified herein and or shown on the system drawings must be "starred", highlighted in yellow and noted in ¼" high letters on the shop drawings and submittal data.

E. Approval of shop drawings and materials does not relieve the Contractor of any responsibilities.

F. Samples may be requested by the Architect and shall be furnished for inspection at the Architect's office, at the Contractor's sole expense.

G. Submit in quantities as required by the Architect.

H. Shop drawings and submittals shall be revised and resubmitted as required.

I. Four months prior to system activation for contractor testing submit a complete written narrative describing all system DSP and control programming and functionality.

J. One month prior to system activation for contractor testing submit the initial DSP configuration file and screen shots of all control pages for all control systems.

3.1 COORDINATION WITH OTHER WORK

A. The sound contractor shall specifically coordinate the placement and sizes of conduit relating to this work and shall specifically review and approve the conduit rough-in in time to advise all parties of needed changes, omissions, etc. The sound contractor shall report this successful coordination in writing to the owner's representative. Failing this, the following will be enforced:

1. The sound contractor shall provide and install any additional conduits required for the hookup, proper location and proper isolation of the various cable / signal types and equipment in the systems. The sound contractor must coordinate his conduit installation with those installed by the electrical contractor. All conduits shall be sized to their intended fill plus fifty percent.

2. The contractor shall at all times coordinate his work with the other trades to ensure smooth progress of work and satisfactory final results.

3.2 INSTALLATION

A. Personnel: A single, competent, technically qualified foreman will oversee the entire job from start to finish. This foreman must:

1. Be present on the job site during all phases of installation and testing.
2. Be authorized to receive instructions from the Architects or their representative.
3. Only experienced sound installers shall be employed on this job.

B. The contractor shall keep the job adequately staffed at all times.

C. All job documents pertaining to the installation of this system will be accessible to all workers throughout the installation process.

D. Installation practices shall be in accordance with OSHA Safety and Health standards and all local codes.

E. The sound contractor shall not commence the installation of equipment and devices, other than the pulling of cable, until all areas are clean, painted and finished to a point that they are completely dust, dirt, lint, fiber and airborne particle free. The air conditioning system must be operating to its design level and be able to keep all areas with sound equipment stable.

F. General Workmanship:

1. 1. The installation of all work shall be neat.
2. All boxes, equipment, etc shall be plumb and square.
3. The installation shall conform to the plans and spec.
4. Equipment racks shall be assembled, wired and tested in the contractors shop prior to delivery to the job site.

G. Wiring:

1. If enclosed in conduit run only similar signal levels in a single conduit.
2. All pulls to be made be hand, care will be taken not to nick cable jackets, and any nicked or damaged cable will be replaced.
3. A pull string will be left in all conduits after wire is installed.
   NO SPLICES WHATSOEVER IN CONDUIT!
5. If not enclosed in conduit neatly group cables into bundles and secure out of harms way.
6. Separate cable grouping by signal level. Mic and A.C. power shall be not less than 18" all other levels by not less than 6".
7. Include spare cables with all field runs. Quantity to be 10% or 1 which ever is greater unless otherwise specified.

H. Terminations:

1. All cables shall be permanently labeled at every termination.
2. Service loops of not less than 6" will be present at all terminations to equipment.
3. Where terminal blocks or barrier strips are used only uninsulated fork terminals with a brazed seam, sized according to wire and stud sizes, crimped with notch across from the seam will be approved.
4. Use barrier strips on equipment where provided.

5. Where shielded cable is in use leave shield drain wire the same length as the circuit conductor(s), sleeve shield drain wire in green pvc tubing. Cap where the cable jacket was removed with heat shrink. Where the shield drain wire is to be lifted follow the above and fold back over cable jacket. Then cap end with heatshrink. Do not use a single piece of heatshrink for this use two smaller ones.
6. All soldering will be clean and neat and not exhibit evidence of a " cold" joint, were necessary heat sinks will be used. Use only rosin core "electronic type " solder.
7. Wire nuts will be allowed only for field connections of 70 volt speaker lines and priority attenuation control lines, and then only when the proper size is used.

I. Polarity:

1. The " high " side will be connected to pin 2 on XLR connectors, to tip on 1/4" connectors and to the pin on phono connectors.
2. The " low " side will be connected to pin 3 on XLR connectors, to ring on 1/4" balanced connectors and to case on phono connectors.
3. Microphones will be wired so that an acoustic compression at the diaphragm produces a positive going signal on pin 2 with respect to pin 3.
4. Speakers will be wired so that when a positive going signal is applied to the + or red terminal an acoustic compression is produced.
5. The system will be wired to maintain absolute polarity through all system components to insure that a positive signal on pin 2 or tip produces a positive signal at the + or red speaker terminal.
6. All audio low-level signal lines will be balanced and floating.

J. Shield Grounding:

1. Do not tie pin 1 to case of XLR connectors anywhere.
2. Microphone shield drain wire will be grounded only at mixer inputs. Where microphone lines and mixer inputs run though a patchbay connect shield drain wire to sleeve of patchbay connector and only to this point.
3. Line level lines will have shield drain wire lifted from ground at outputs and connected to ground at inputs.
4. The intent here is to not make ground loops, should any situation arise which would form a ground loop, please inform the owner for direction.

K. Mounting and Attachments:

1. Any and all structural, mounting, or rigging details are shown on the drawings for concept only.
2. The detailed drawings and calculations of all proposed mounting or rigging of any equipment weighing more than ten pounds will be approved and stamped by a P.E. who is licensed in Mass.. Each cluster element is to be individually adjustable.
3. Provide for an adjustment range of +/- 10 degrees from the information shown in the contract documents.
5. In the absence of specific direction otherwise, standard rigging practices shall be followed.

L. Labels:

1. Cable Labels: All cables shall be labeled at all termination points. The label shall not be hand written. Clear heat shrink shall cover the label.
2. Equipment Labels. All equipment shall be labeled front and rear. Labels shall functionally describe the use of each piece of equipment. On equipment having multiple channels, each channel shall be labeled. Additionally the equipment label will call out equipment designation which will correspond with the designations shown on the approved contractor's one-line diagram. Labels shall be engraved lanacoid, white letters on black background, with a minimum letter size of 3/16". Approved patchbay labeling may vary from this.

M. Power Sequencing. The system shall turn on and off, in proper order, on circuit at a time, when the power switch is pressed. The power light shall be solid on when all circuits are on and shall flash during sequencing.

1. Provide all power wiring inside racks.
2. Provide all required power cables for portable equipment, self-powered speakers, etc.

N. The system may not be used prior to checkout.

3.3 INSPECTION AND TESTING:

A. During the installation of the equipment the sound contractor shall arrange for visits as necessary for inspection of equipment by the owner's and/or architect's representatives.

B. Provide a safe means of accessing all system components for all visits.

C. Equipment Pretesting

1. All racks are to be built and wired in contractors shop and tested prior to delivery to site.
2. All other equipment is to be tested prior to delivery and installation.
3. A written test report will be submitted to the owner that will include at a minimum:

a) Transfer function measurements showing frequency response, phase response and either coherence or signal / noise ratio for each speaker.
b) A composite chart which overlays all similar speaker model plots onto a single chart where the magnitude of the frequency response has been normalized across all included speakers.
c) Cable certifier printouts for all network / CAT type cable links.
d) TDR plots of all coax type cables.
e) Cable tester reports for opens / shorts / crossover / connections to ground of all mic jack, line jack, monitor speaker and line cabling.
f) Speaker Z plots for all installed speakers /speaker lines. 70V systems need not be separated, all other speaker lines must be measured one speaker at a time.
g) A composite chart which overlays all similar speaker Z plots onto a single chart.

D. Final Inspection:

1. The final inspection will confirm that the systems, as installed, meets the requirements of this spec, the contract documents, and the approved contractor's shop drawing and submittals.
2. The Theatre Consultant or his representative will conduct all final system tests and equalization adjustments in order to determine final acceptance.
3. In no event shall the theatrical sound systems installation be submitted for final approval or acceptance until any and all elements of the facility that may have a bearing on the system performance, including but not limited to doors, windows, HVAC, carpeting, furniture, wall coverings, interior design elements, lighting and lighting control systems have been completed and are operable. All elements that may effect sound systems operation or performance shall be "on" and operating during adjustments. The sound contractor will be responsible for coordinating the requirements of this paragraph with other work on the project.
4. The contractor will inform the owner in writing of the system's completion. The contractor will then request final inspection by the consultant, and carry out the necessary coordination. This coordination includes:

a) Giving at least fourteen days notice to the consultant prior to the final inspection.
b) Arranging for the contractor's and consultant's exclusive use of the space.

c) Arranging for a HVAC technician to be available to turn the AC system on and off as required.
d) Arranging for a lighting technician to be available to control the stage lighting as required.
e) The contractor's job foreman and one additional worker familiar with the job will be present during all check out, testing and tuning.

5. Contractor will complete the following tasks prior to consultant's arrival:

a) Unpack and assemble all portable equipment.
b) Place all portable equipment in one location.
c) If anything has been turned over to the owner have the signed Letters of Transmittal on site.
d) Complete all required paperwork (pre-testing reports, letters indicating successful coordination of the installation, etc.).
e) Remove all security covers.
f) Unlock all doors.

6. Contractor will provide all necessary software, cables, and interfaces to facilitate the setting of computer, remote controlled, or DSP based equipment.
7. Contractor will either: 1) relocate all system equalizers to a tech area in the house for the duration of system tuning or 2) for remotely controllable devices, locate the control position in a tech area in the house for the duration of system testing. In either case a tech area in the house will be required with a minimum of a 4' x 6' folding table, intercom communications to the rack and console locations, and AC power.
8. Contractor will provide the following test equipment for use during tuning and acceptance testing:

a) Sennheiser ZP-3 impedance bridge.
b) Low distortion sine wave oscillator with variable sweep (start frequency, stop frequency, and sweep rate).
c) Distortion meter.
d) Oscilloscope dual channel 20MHz, .001v/div vertical amp.
e) Noise generator that will provide pink, white, or bandwidth limited pink noise.
f) 1/3 octave real time audio spectrum analyzer.
g) Precision sound level meter with filter set.
h) Polarity checker.
i) Precision true R.M.S. reading A.C. millivolt meter with dB scale.
j) Meyer Sound SIM 3 with all interconnection cabling and a DPA 4007 mic with calibrator OR full Smaart rig OR a full Syst Tune rig.
k) Speaker Z measuring jig for the above test system or dedicated speaker Z measurement equipment
a. Playback and recording media for testing all supplied source equipment.

9. Contractor will provide safe means to access all system components during the entire commissioning process.
10. Contractor shall provide personal and equipment to make adjustments to the speaker cluster(s), as well as to correct problems, for the entire inspection and testing period.

Should more than one trip be required to complete the systems testing, systems tuning, and clearing punch list items, the contractor will be charged for any additional visits. These charges will include:

1. A minimum of two people at a day rate of $1250 per person, per day.
2. These charges will be paid to the consultant, in advance of the consultants arrival on the job site.

3.4 MANUALS

A. Prepare four identical copies of owner's manuals. The owner is to receive two, the consultant receives one and the contractor retains one. Before distribution of manuals submit one copy to consultant for approval. Each manual is to contain the following:

1. System one line drawing including all labeling and changes (" as builts ").
2. Owner's manual for each piece of equipment.
3. Schematic diagram for each piece of equipment.
4. Contractors service phone number in a conspicuous place.
5. All test reports.
6. Electronic (PDF) copy of the manual (indexed with TOC and links to sections)
7. Electronic (USB flash drives) loaded with the PDF manual and all software, drivers and configuration files.

3.5 INSTRUCTION

A. The following is to be carried out within two months of system acceptance

B. Provide a total of 16 hours of instruction, on a maximum of two occasions. This is to be time on site, travel time is not to be included within the allotted time.

C. Provide operational assistance for the first usage of the system. This is to be on the owners time schedule but, not to exceed 8 hours.

D. The general conditions require all training sessions to be videotaped. This contractor is to coordinate with this requirement and if required performing the taping.

3.6 WARRANTY

A. Contractor will warrant the system to be free from defects in materials and workmanship for a period of one year from the date of acceptance or first beneficial use, whichever comes first.

B. Acts of god and owner abuse, or neglect are not covered.

C. During the warranty period the contractor will respond to and correct any call for service within one day of the call. Loaner equipment will be provided if necessary.

END OF SECTION 274118

SECTION 27 42 00 – IP VIDEO DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Digital Video Distribution

B. Digital Video Storage

C. Digital Video Servers

D. Digital Video Encoders and Decoders

E. Taps, Splitters and Amplifiers

1.2 SYSTEM DESCRIPTION

A. Design Requirements:

1. Furnish and install all equipment for digital video cap[illegible] stor[illegible] and streaming

2. Include all labor, materials, equipment and servi[illegible]equire[illegible]r complete installation and related work as specified in this Section including (b[illegible] not [illegible]ited to) connection of all circuits, apparatus, and equipment required to deliver complet[illegible] oper[illegible]le s[illegible]em to the school, ready for use.

3. Coordinate installation with local cable service p[illegible]vid[illegible], including securing services of local cable service provider for providing complete and opera[illegible]al system as described below.

B. Performance Requirements:

1. Provide a fully integrated and [illegible]tional H.264 video streaming system capable of forward and reverse operations, cl[illegible]ick[illegible]hannels, video storage and content distribution.

a. Provide IP [illegible]elevision [illegible]lets in classrooms to allow for reception of forward channels as well as for inse[illegible]on of rem[illegible]e origination information and/or remote control of head-end.

b. P[illegible]vide each p[illegible] system complete in detail and operable in unison with all other sections, [illegible]ovidi[illegible]a completely installed television distribution system and connections, as described i[illegible] Section.

c. Provi[illegible]ll work, materials, and manner of placement in strict accordance with requirements of latest edition of National Electrical Code.

Provide all materials listed as complying with available standards of Underwriter's laboratories or other similarly established standards and carry their label. Apply all materials in strict accordance with Underwriter's laboratories listing.

e. All work described in this Section performed by Contractor or approved qualified subcontractor.

1.3 SUBMITTALS

A. Product Data

1. Submit manufacturer's latest publication, part numbers and quantity listings of all supplied components:

a. Severs

b. Storage Units

c. Encoders and Decoders

d. Software Applications

B. Shop Drawings:

1. Contractor shall submit original specification sheets or clear copies of the same on all items. Manufacturer's name, make and model number shall appear on each sheet. Submittals shall be indexed and presented in a neat and logical order in a binder. Submittals shall contain installation, operation and programming manuals of the proposed equipment and systems to provide the Authority and Design consultant complete information as to system features, functions and capabilities.

2. The Contractor shall submit line drawings of all systems showing major components of the systems. Submit wiring diagrams showing typical connections for all systems and equipment. Submit equipment rack elevations, line diagrams and equipment locations and wiring diagrams.

3. The Contractor shall submit to the Design consultant for approval, prior to the installation of any part of the video distribution system, design consultant drawings of the system showing the interconnections of all equipment with the designed video distribution system with calculated signal levels. Specification sheets covering all component parts of the system shall be submitted along with the design consultant drawings. The system and equipment as shown on the design consultant drawings and specification sheets shall meet all items of the specifications.

C. As-Built Drawings

1. Provide riser drawings of complete system including all device locations and cabling.

2. Provide complete headend rack layout and elevations.

3. Provide 1/8" scale drawings in hard copy and electronic AutoCad 2015 format for review and acceptance by the architect and owner prior to completion

1.4 QUALITY CRITERIA

A. Qualifications

1. All work in conjunction with this installation shall be in accordance with good design consultant practices. The installation shall be in accordance with the latest requirements of the National Electrical Code, State and local codes, ordinances and regulations of any other governing body having jurisdiction.

2. The Contractor shall submit a list to include at least five of the Contractor's installations of the proposed Video Distribution systems, which have been in satisfactory operation for a minimum period of three years.

3. All system equipment shall be limited to the products regularly produced and recommended for service ratings in accordance with design consultant data or other comprehensive literature made available and in effect at the time of bidding.

4. The Contractor shall have been in the video distribution system integration installation business not less than 5 years prior to the bid date.

5. The Contractor shall be an authorized distributor for the proposed equipment and system with full manufacturer's warranty privileges.

6. The Contractor shall maintain a complete inventory of all parts necessary for satisfactory service and maintenance of the proposed system.

7. The Contractor shall provide equipment of one manufacturer for the system and bulletin board components of the video distribution system unless specifically approved in writing by the Design consultant.

B. Industry Codes, Standards and Methods shall be observed, including the following:

1. ANSI/TIA-568.0-D: Generic Telecommunications Cabling for Customer Premises.

2. ANSI/TIA-568.1-D: Commercial Building Telecommunications Cabling Standard

3. ANSI/TIA-568-C.2: Balanced Twisted Pair Cabling and Components Standard

4. ANSI/TIA-568.3-D: Optical Fiber Cabling Components Standard

5. ANSI/TIA-569-D: Telecommunications Pathways and Spaces

6. ANSI/TIA-570-C: Residential Telecommunications Cabling Standard

7. ANSI/TIA-606-B: 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-B: Customer-Owned Outside Plant Telecommunications Cabling Standard

10. ANSI/TIA-4966: Telecommunications Infrastructure Standards for Educational Facilities

11. BICSI Telecommunications Distribution Methods Manual (TDMM), Latest Edition

12. National Fire Protection Agency (NFPA-70): National Electrical Code (NEC)

13. System wiring shall be in accordance with good design consultant practices as established by the EIA and NEC. Wiring shall meet all established State and local electrical codes. All wiring shall test free from ground and shorts.

1.5 QUALITY ASSURANCE

A. 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 t 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.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials in good condition, store in a dry place, off ground, and keep [illegible] all times.

B. Materials should be clearly marked with project name, number and Contractor's name.

C. If equipment is dropped and damaged, it is to be replaced at the contractor's expense.

1.7 WARRANTY

A. The Contractor shall warrant the equipment to be new and free from defects in materials and workmanship and will, within two years from the date of acceptance, repair or replace [illegible] any part of the equipment found to be defective. Warranty maintenance, shall be provided by the Contractor during normal working hours at no expense to the Authority.

B. At the completion of the job and before final acceptance the Contractor shall guarantee in writing that the systems are properly adjusted and shall warrant the system free from defects for a period of two (2) years from the date of Final Acceptance by the Authority. In addition, the Contractor shall provide a guaranteed service response time of not more than 48 hours from the time of receipt of a trouble call. Service and maintenance during the two-year warranty period shall include all parts and labor and shall be at no additional cost to the Authority.

1.8 AUTHORITY'S INSTRUCTION

A. A comprehensive installation, operation, programming and instruction manual shall be supplied as part of the system. The manual shall provide complete service information, including schematics, layout drawings, and interconnection diagrams showing the location of all the outlets, cable taps, cable routes, and other installed components. Include final "as built" one-line system drawings. Include for this particular project parts list to permit quick and efficient maintenance and repair of the equipment by qualified technicians. Manuals shall include 8-1/2" x 11" device location/cabling route drawings provided in CAD format (AutoDesk - AutoCad 2015 or later). Manuals shall include a copy of the operations manuals. Manuals shall be indexed and neatly bound in a hardcover three ring binder. Three (3) copies of this material shall be provided to the Authority upon project completion. Contractor shall retain a minimum of one (1) copy for their permanent records.

1.9 COMMISIONING

A. Authority reserves the right to determine the final approval of the system at the time of scheduled job completion. Failure to meet the installation schedule or provide the "precise functional equivalent" shall result in the removal of the system at the Contractor's expense

B. The Contractor shall furnish 3 - four (4) hour sessions of in service training with the system. Operating manuals and user guides shall be provided at the time of the training. Provide a minimum of three operating manuals.

1.10 MAINTENANCE

A. The Contractor or his subcontractor shall show satisfactory evidence, upon request, that he maintains a fully equipped service organization, capable of furnishing adequate inspection and service to the system, including standard replacement parts. He or his agent shall be prepared to offer a service contract for the maintenance of the system after the guarantee period

B. Diagrams: The Contractor shall furnish three complete sets of operating instructions, including cable diagrams, and other information necessary for proper installation, operation and maintenance of the system components. As-built drawings of the system shall be supplied. These drawings shall include signal levels measured throughout the TV/video system as they were at the acceptance date of the system.

C. Service Calls: Provide 8 hours of service calls on system in school after final acceptance to make any adjustments necessary to keep system at peak operating condition. Service calls performed as requested by the School. Warranty work is not included in the service call time.

D. Service Contract: Equipment Supplier: Accredited by proposed equipment manufacturers and prepared to offer service contract for system maintenance on completion of guarantee period and provide names, locations, and size of 10 recent successful installations in area; 24 hours per day service with 24 hour non-emergency service response time provided, and including 1 hour emergency call response time on 365-day-per-year, 24 hours per day basis.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Video Distribution equipment: Media Master.

1. Or Haivision

2. Or VBrick

B. Digital Signage equipment basis of design shall be Media Master.

1. Or Haivision

2. Or VBrick

C. Any products submitted as equals must be approved by the designer prior to approval and purchase.

2.2 EXISTING PRODUCTS

A. The Contractor shall coordinate all interface requirements with new and existing equipment to insure seamless operation. Existing equipment is not to impede the usage of the new equipment.

B. Existing Products must be handled and cared for properly to prevent any damage during installation.

2.3 EQUIPMENT

A. [ ] Video Equipment

1. Splitter

a. Blonder Tongue 1000 MHz 4 port

2. TV Tuner

a. Aurora V-Tune Pro 4K

b. AVerTV Hybrid TVBox 13

3. DVD Player

a. Denon DBT-1713UD

4. IP Video Platform

a. Media Master

5. Digital Signage Software

a. Media Master Presto video

6. Digital Signage Hardware

a. Media Master MM-1803 Converter

7. Power Strip

a. APC 1RU 120v 10 Port 15 AMP

8. UPS

a. APC 3000 VAC Smart UPS

9. Equipment Cabinet

a. Hubbell 42 RU Vented Equipment Cabi

10. Decoders / STB

a. Media Master MM-1776

11. Encoders

a. Media Master MM- 1-HD

B. Mobile Cart

1. Media Master M 1581

a. Wit Erica Mini xer

b. Port G bit Switch

c. B y Player

d. Encode

Decoder

Displays

55” LED Commercial Grade Display

a. NEC V554-AVT3

b. Or approved equal

PART 3 - EXECUTION

3.1 ACCEPTABLE INSTALLERS

A. Contractor must be a licensed installer for the equipment which the contract is registered. Contractor is responsible for the necessary permit to do the job. The contractor must have a minimum of three years of video digital installation with a school and provide references for said work.

3.2 EXAMINATION

A. Site Verifications of Conditions

3.3 INSTALLATION

A. Equipment and Distribution:

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. All cables shall be fastened securely with suitable hardware and as to avoid sharp bends and to prevent rubbing against sharp corners and in a manner to prevent injury or physical distortion.

3. All connections shall be made with suitable connectors only at approved point or where otherwise indicated on the drawings to facilitate later system service. There shall be no splicing of coaxial cables.

4. Wiring for all wall-mounted equipment shall be concealed in raceway (conduit) from outlet to above removable ceilings, unless noted otherwise.

5. Wiring installed above removable ceilings shall be installed on bridle rings. No cables shall be installed on roof or exterior of building.

6. Equipment properly mounted on panelboard, neatly arranged in orderly fashion and accurately identified.

7. Equipment cabinet(s) anchored to wall or floor utilizing an approved method.

8. All head-end equipment securely installed within equipment cabinet(s) by screws, bolts, nuts, etc or by method approved by Design Consultant. All holes intended for equipment mounting used for securing equipment to rack. Provide all exposed hardware in same color and type, preferably matching cabinet finish (i.e. black cabinet-black rack screws).

9. Incoming service cable shall be provided by the CATV Company and shall be extended to the new headend location by the Contractor. Contractor is to schedule with the local cable service provider to ensure completion in a timely manner with project schedule.

10. Provide accurate documentation listing all equipment install under this section. This includes; equipment manuals, part numbers, serial numbers, warranties, and location of equipment. If information is found inaccurate during the one-year warranty period, Contractor is required to re-verify all equipment information at no additional cost to client.

3.4 FIELD QUALITY CONTROL

A. Site Tests and Inspections:

1. Test every outlet for signal level, clear picture and remote origination/control (as applicable).

a. Select one outlet per cable tap and view picture with television. Observe all active channels. Ensure picture is clear with no visual presence of interference of any kind and no audible variance in volume level between channels.

2. Test all head-end equipment for proper frequency, audio/video carrier levels, and RF level outputs. Adjust all levels per manufacturer's recommendations.

3. Perform all testing required for each building during same day.

4. Perform tests to all systems under direct supervision of manufacturer's representatives or accredit agencies for all specified equipment and services.

5. Submit all test results in tabular format with reference to or backed up by equipment/riser diagr that accurately represents installed system.

6. Submit written test report from authorized representative of equipment manufac r stat that system has been tested and is in working order prior to final inspection by Design C ultan

7. Upon completion of the installation of the equipment, the video Contrac r shall vide the Design consultant a signed statement from the equipment supplier th e system s been wired, tested, and functions properly according to the specifications.

8. The minimum operating test observations shall be as follows

   a. Should the demonstration of performance show that Contrac r has not properly balanced the system and that picture degradation is pres r tha e o put is not as specified, the Contractor shall immediately make all necessary a ges djustments at no additional cost to the Authority and a second performa monstr n conducted.

9. The testing agency making the measureme shal e id ified, and the data must be signed and dated by the testing technician.

10. The Contractor shall furnish all equipment and per nnel required for the test.

3.5 DEMONSTRATION

A. School Training: Provide minimum s of training for School personnel per building used at School's sole discretion and schedule Sch l to fit the School's needs.

   1. Training schedul by Schoo n blocks of 2-8 hours.

   2. Include all r die ravel sts, etc., in cost of training.

   3. Begi ining er design consultant deems system physically complete and fully operation. Service ot deemed as training.

   4. Include follo g minimum content in training:

      a. General systems overview describing sub-systems and their relationships with each other.

      b. Specifics on sub-systems and how to maintain them to ensure reliable operations.

      c. Operation of equipment to perform intended tasks, including (but not limited to) remote origination, camera operation, television operation, cable patching, fuse replacement and so forth.

      d. Provide written documentation for all training attendees to supplement training (i.e. diagrams, training outlines/highlights, etc.).

END OF SECTION

SECTION 28 20 00 - VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Video Surveillance Cabling, Cameras, NVRs, Control Equipment, Cabling and interface units.

B. Associated power supplies, terminations, labeling and associated cable performance testing.

C. All materials, terminations, equipment, labeling and associated cable performance testing.

1.2 Definitions

A. Refer to sections 27 and 28 for applicable definitions and terms.

B. CCTV and video surveillance refer to the same system and are used interchangeably. Terms refer to cabling system included in this specification section.

1.3 System Description

A. Design Requirements

1. Provide labor, materials, equipment, services and operations required for complete installation of a CCTV System.

a. Fiber/PoE extenders and associated power wiring shall be homerun from end device location to headend equipment location without breaks or splices.

b. Cat 6 UTP network cables with all terminations from cameras to switches and control equipment shall be installed without splicing.

c. Cables shall be routed from distribution racks throughout building as shown on T-Drawings.

i. Refer to notes on each drawing to determine exact installation methods.

ii. Note and record all cable lengths to the nearest foot.

iii. Strictly adhere to most current version of ANSI/TIA Telecommunications cabling standards.

d. Permanently identify and label all cables and termination devices, at distribution rack and workstation in accordance with ANSI/TIA-606 Standard or as agreed by Design consultant and Authority.

e. Remove and replace any cables failing to meet end-to-end testing requirements; do not abandon cable in place. All cable shall be terminated at both ends, unless noted in T-Drawings.

B. CCTV System Requirements

1. The system shall provide notification of events occurring on the system

2. The system shall be on emergency power systems

3. The system shall be on the local area network

4. The system shall integrate with other currently installed systems within the district.

5. The system shall be field controllable and programmable.

6. The system shall allow for access restriction.

7. Contractor shall be responsible for form, fit, function, and coordination of all pa numbers listed above, and bring to owner's attention any changes or substitutions approval.

8. No surface metal raceway shall be used unless approved by owner, a if app ved, shall be painted to match adjacent wall color.

C. Performance Requirements

1. Comply with applicable requirements in Local, State and Fede Co s, TIA/EIA Standards, and BICSI methodology.

2. Specified cabling system derived from recomme ions in pproved telecommunications industry codes, standard nd m od including the following documents:

a. ANSI/TIA-568-C.0: Generic Teleco ications Cabling for Customer Premises.

b. ANSI/TIA-568-C.1: Commercial ing Telecommunications Cabling Standard

c. ANSI/TIA-568 2: P d Twisted Pair Cabling and Components Standard

d. ANSI/TI C.3 ptical Fiber Cabling Components Standard

e. ANSI TIA-569- Commercial Building Standard for Telecommunications Pathw s and Sp ces

f. ANSI/TIA-570-B: Residential Telecommunications Cabling Standard

g. SI/TIA-606-A: Administration Standard for Telecommunications nfrastructure of Commercial Buildings

h. ANSI-J-STD-607-A: 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)

1.4 Submittals

A. Comply with requirements of Division 0 and Division 1 - Submittals and as modified below.

B. Product Data: Submit manufacturer's product literature, technical specifications and similar information for the following items demonstrating compliance with the specified requirements.

1. Video Recorder Units (NVRs)
2. Cameras
3. Fiber and PoE extenders
4. Copper cable, patch cables and termination devices
5. Video Surveillance Control Software
6. Video Surveillance Control Servers
7. Inner duct and accessories
8. Complete Wiring diagrams
9. Sample of each cable test report.

C. Shop Drawings: Provide complete shop drawings showing devices, device connections, wiring pathways, wire types, headend equipment elevations and associated components prior to installation, for approval by designer.

1. Shop drawings shall be submitted in AutoCad and PDF format.

D. Quality Control Submittal

1. Test Reports: Submit complete sample test data and reports with exact labels used on cables and patch panels.
2. Certificates
   a. Manufacturer Certification: Submit certification from manufacturer of products to be installed under this contract certifying that Installer is authorized by manufacturer to install specified products.
   b. Installer Experience Listing: Submit list of at least 5 completed projects as specified below in "Quality Assurance – Qualifications – Installer."

E. Contract Closeout Submittal: Comply with requirements of Division 0, including submission of operating and maintenance instructions as item in "Operation and Maintenance Data" manual described in that Section.

1.5 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 WCPS personnel. Any work found to be of inferior quality and/or workmanship shall be replaced and/or reworked until the approval of WCPS is obtained.

B. Qualifications

1. Installer
   a. Qualified to cable, terminate and test data network cabling system, coaxial cable system and associated power wiring specified in this Section and section 271000,

certified by manufacturer of products to be installed, and completed at least 5 installations of similar size, nature and complexity as specified for this project.

C. Conditions for Consideration of "Or Equal" Products: Where products are specified by name and accompanied by the term "or equal", the proposed "or equal" product will be considered when the following conditions are satisfied. If all the following conditions are not satisfied, 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.

1.6 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 UTP camera wiring system shall be provided by the Manufacturer as follows:

1. System Certification: Upon successful completion of the installation and subsequent inspection, the Authority shall be provided with a numbered certificate, from the manufacturing company, registering the installation.

C. Manufacturer warranty coverage for coaxial cable systems associated with the CCTV System.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Video Surveillance Equipment

1. Exacq

B. Equipment Cabinet

1. Floor mounted 84” equipment cabinet.

2. See Section 270500 for details

C. Cabling Components for video surveillance systems. (PROVIDED/INSTALLED BY DIVISION 271000 CONTRACTOR)

1. UTP Camera Cabling (Plenum Rated)

a. CCTV System cabling shall be a distinct color.

b. Camera cabling shall provide identical performance to Cat 6 UTP data and voice cabling included in Section 27 10 00 and meet all district performance criteria.

c. Third-party verified to meet TIA/EIA Category 6 requirements. All completed cabling channels fully backwards compatible with requirements of Category 5 and 5e cabling systems.

d. See section 27 10 00 for cabling requirements.

2. Fiber Optic Strands (Plenum Rated)

a. 50 Micron OM4 multimode Fiber Optic Strands: Ultra rated to 10 Gbps, fiber optic cable with 8.3/125 micron core/cladding diameters, 900 mm buffer.

3. Patch Panels for CCTV Cabling

a. All patch panels must provide identical performance to Cat 6 patch panels included in Section 27 10 00 and meet all district performance criteria

b. Shall meet requirements for category 6 (per SCHOOL DISTRICT standards) performance requirements.

c. Panels shall contain the number of termination ports required to terminate all LAN and telephone jacks in service area, plus 20% spare capacity.

d. Acceptable units:

e. See section 27 10 00

f. Panels shall contain the number of termination ports required to terminate all LAN and telephone jacks in service area, plus 20% spare capacity.

4. Patch Cables for CCTV Cabling

a. Factory terminated and tested UTP patch cables at workstation and equipment cross-connect meeting requirements of ANSI/TIA/EIA-568-B for patch cable testing.

D. Video Management System (VMS)

1. ExacqVision Professional VMS

E. Video Surveillance NVRs

1. Exacq 6408-144T-R4Z.

2. NVRs shall provide storage for all cameras at full resolution, 75% activity in a 24 hour period at 10 fps.

3. Provide necessary quantity of NVRs required.

F. CCTV Cameras

1. Interior cameras shall be an Axis M3044 1 mp dome (or approved equal) ceiling/wall mount color units.

2. Exterior units shall be an Axis M3026 3 mp pendant (or approved equal) and dome with associated mounts.

3. 180˚ Cameras shall be Axis Q3708-PVE Network Camera (or approved equal) dome with associated mounts.

4. 360˚ Cameras shall be Axis P3717-PLE Network Cameras (or approved equal) dome with associated mounts.

G. Owner shall provide the system with static IP addresses as needed for multiplexers, and remote master viewing station (PCs) access. Contractor shall supply the Owner with a minimum of (4) copies of software

H. The Owner shall supply remote viewing station PCs.

I. Provide ceiling or wall mount TV bracket to support flat screen LCD TVs as indicated on drawings. These TVs shall be wired directly by dedicated cable. Contractor shall provide LCD TV's and coordinate placement with owner's representative.

J. CCTV Wiring (PROVIDED/INSTALLED BY DIVISION 271000 CONTRACTOR)

1. Network One Reach system (for site cameras) over 90 meters

2. 50 micron OM4 Multi-Mode Fiber

3. Cat 6 UTP

4. 18/2 AWG

PART 3 - EXECUTION

3.1 Examination

A. Verification of Conditions: Examine conditions under which CCTV and Access Control 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 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.

3.2 Preparation

A. Protection: Provide adequate protection of equipment and hardware before and after installation.

B. Existing Communications Services: Ensure all telecommunications systems (voice, video and data) remain operational throughout the project.

1. Identify any circuits and/or wiring in the space 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.

3.3 Installation

A. Provide and install all components necessary to install complete telecommunications cabling and equipment systems, including (but is not limited to) connectors, patch cables, terminators, etc.

1. Cable runs shall be continuous and unbroken from end to end. Splicing of any LAN, Horizontal, Homerun multi conductor cable or coaxial video distribution cable is prohibited.

2. Secure all horizontal cables within ceiling cavities to 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. Install cables in EMT in all unfinished, exposed areas as shown in Design consultant and Architectural roof plans and/or T-Drawings, unless alternate pathways are noted.

8. Do not secure cables with permanent cable ties. Do not tighten cable bundles in such a way as to cause jacket deformation or damage.

9. Provide a minimum of 15' of cable slack at camera location and 10 feet at patch panels, unless noted otherwise. Do not coil cable slack

10. Place cables in compliance with ANSI/TIA-568.C standards and BICSI recommended methods.

11. Tight 90-degree bends are unacceptable and use of plastic "cinch-type tie-wraps" are not permitted, in order to prevent damage to cable jacket and compromise the cable's electrical or optical characteristics.

12. Cable bundles shall be neatly routed with a service loop to provide 10 feet of slack at the cross-connect end and as noted in the T-drawings. Cable bundles shall be secured using only black Velcro cable wraps.

13. 10 feet of service slack shall be provided in the ceiling at each device location. Contractor shall not secure service loop in conduit but route in such a manner as to minimize EMI.

B. Install all exposed cabling in surface raceways by Wiremold, Hubbell or Panduit where in-wall conduit has not been provided. Follow all manufacturers' guidelines requirements regarding bending radius and slack. All bend radius sets and fittings shall be appropriately sized to provide 30% capacity for installation.

C. 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.

D. Properly terminate all cables at camera locations and distribution racks. Permanently identify all cables, pull boxes, transition points, and termination points by affixing pre-marked self-adhesive wraps similar to Brady "B-500+ Plastic Cloth Markers."

E. Permanently identify all system components following ANSI/TIA 606 "Administration Standard for Commercial Telecommunications Infrastructure" with identification format:

1. Identification: Provide permanent identification labels for patch panels, access panels and entrance facilities.

3. Testing

A. Video Surveillance System

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

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

3. All aspects of the management and control system shall be tested and shown to operate as specified by the manufacturer.

3.5 As-Builts

A. Accurate as-built drawings shall be provided in electronic and hard copy format.

1. 3 copies of electronic (CAD) drawings shall be distributed on appropriate media 1 to construction management, 1 to designers and 1 to the school district.

2. 3 hard copies of CAD drawings shall be plotted on full size sheets and test results of every installed cable have been given to the construction management for appropriate distribution.

B. As-builts shall accurately show all devices, wiring, control equipment, rack elevations, equipment elevations and system interconnections.

3.6 Demonstration

A. Video Systems Demonstration

1. 16 Hours of demonstration and training on all aspects of the completely installed systems must be provided for the owner.

a. Training shall be video recorded for the owner and given to them after acceptance.

b. Training and system demonstration must include all aspects of the system and its operation.

c. Additional training, beyond the initial 16 hours, shall be provided for the owner at their request on an hourly rate basis.

3.7 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 aspects of the system have been shown to operate as per manufacturer's specifications.

3. A school district security representative has successfully tested the "LIVE" system.

4. All punch list items have been reconciled.

5. All disturbed ceiling panels, covers, etc. have been properly reinstalled.

6. All materials and trash have been removed from the site.

7. A 1-Year Installers warranty has been given to a school district Security representative.

8. Submit Manufacturers Extended Warranty Application.

END OF SECTION

SECTION 311000 - SITE CLEARING

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. Protecting existing trees, shrubs, plants and grass to remain.
2. Removing existing trees and other vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and abandoning site utilities in place and removing site utilities.
7. Temporary erosion and sedimentation control measures.

B. Related Sections include the following:

1. Division 01 Section "Temporary Construction Utilities, Facilities & Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities.
2. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.
3. Division 32 Section "Turf and Grasses" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

1.3 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, fertile, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

1.6 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

C. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earth Moving."

1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly flag trees and vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.

Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to approved Sediment and Erosion Control Drawings.

B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE PROTECTION

A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.

1. Do not store construction materials, debris, or excavated material within fenced area.
2. Do not permit vehicles, equipment, or foot traffic within fenced area.
3. Maintain fenced area free of weeds and trash.

B. Do not excavate within tree protection zones, unless otherwise indicated.

C. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.

1. Employ an arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
2. Replace trees that cannot be repaired and restored to full growth status, as determined by Architect.

3.4 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Construction Manager will arrange to shut off indicated on-site utilities when requested by Contractor.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Construction Manager and Owner not less than five days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Construction Manager's written permission.

C. Excavate for and remove underground utilities indicated to be removed. Refer to sections covering site utilities.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
4. Use only hand methods for grubbing within tree protection zone.
5. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Do not stockpile topsoil within tree protection zones.
2. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate bases as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforement in concrete to remain to prevent corrosion.

3.8 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000

SECTION 312000 – EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Conditions, any Supplementary General Conditions and Division 1, General Requirements, are hereby made a part of this Section as fully as if repeated herein.

1.2 SECTION INCLUDES

A. Earthwork includes areas below building foundations, below concrete slabs on grade, below paved areas and grading of all unpaved area in the site.

1. Layout and staking for earthwork.
2. Excavation and rough grading.
3. Erosion and sediment control.
4. Foundation excavation for footings.
5. Establishing subgrades, leveling and proofrolling.
6. Filling, backfilling and compaction.
7. Keeping streets clean of materials tracked off site.
8. Includes trenching, excavation and backfill for utilities.
9. Maintenance and/or repair of damage to the rough grading.
10. Removal and disposal of stones, debris, debris and unsuitable materials.
11. Soil treatment for termite control.
12. Field quality control, testing, and inspection.

1.3 DEFINITIONS

A. Rock Excavation: Natural geological formations or other material which cannot be removed by adequate equipment (in good condition as defined below, shall be considered a change in the scope of work and paid for by the Owner if encountered.

1. Open Excavation and Grading: Rock in excess of the capabilities of a Caterpillar D-8 tractor (or equivalent) with [illegible] cu. yd. bucket and hydraulically operated single tooth power ripper.
2. Trenches, Pits and Footings: Rock in excess of the capabilities of a Caterpillar 235 Hydraulic Backhoe (or equivalent) using a 2 ft. Bucket width (3/4 cu. yd.)
3. Minimum Effort: If rock is not removed during the process of normal digging and ripping, then extend the excavation to expose the rock surface within the limit of original excavation. Contact the A/E and he may direct the sides of rock to be exposed to a depth of 3 feet. This will be to determine to the extent of additional work.

B. Earth Excavation: Anything not classified as rock including as example: soils, gravels, stones, boulders, vegetation, debris, and unsuitable materials.

C. Unsuitable Materials: All excavated materials; debris, man made or fabricated materials, concrete spoil, organic, soft, expansive, or unstable matter; all shall be disposed of as herein specified. Excessive moisture content shall not classify a material as unsuitable.

D. Removal and disposal of unsuitable material above the subgrade elevation and placement of approved specific fill material (from on or off the site) above the subgrade elevation as directed by the Soils Engineer shall be considered a part of the work.

E. Removal and disposal of unsuitable material approved below the subgrade elevation and placement of approved specific fill material (from on or off the site) below the subgrade elevation as directed by the Soils Engineer shall be considered a change in the scope of work.

F. Soils Engineer or Inspection Agency: An Agency and its designated representatives who monitor and approve all earthwork operations described herein.

G. Subgrade: The finished elevation of the earth immediately below all slabs, granular and porous fill, paving, footings, walls, etc., except the subgrade elevation shall not be higher than 12" below the existi earth elevation at the start of the project.

H. Subgrade for utility construction: Underside of barrel of pipe, or underside of any cradle or bedding noted on drawings, or referenced in applicable local government specifications. For pipe d and miscellaneous structures encased in concrete or on concrete, stone and/or gravel cradle, sub de is lowest outside surface of encasement or cradle.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanics, curbs, nical and electrical appurtenances, or other man-made stationary features constructed above or b ow the g und surface.

J. Bedding Course: Course placed over the excavated subgrade in a trench befo ving pe.

K. Drainage Course: Course supporting the slab on grade that also minimizes upward capillary flow of pore water.

L. Subbase Course: Course placed between the subgrade and ba course hot-mix asphalt pavement, or course placed between the subgrade and a cement co pave t or a cement concrete or hot-mix asphalt walk.

M. Utilities: On site underground pipes, conduits, duc nd cab s, as well as underground services within buildings.

N. Filter Material: Course placed arou dra ge pipes.

1.4 QUALITY ASSURANCE

A. Reference Standards:

1. American Asso tion of S e Highway and Transportation Officials (AASHTO).
2. Americ Society Te g and Materials (ASTM).
3. Dela re Dep ment of Transportation, State Highway Administration “Standard Specifications for M rial and Construction”, October 1993, as amended to date (M.S.H.A. as hereinafter referred elete references to Measurement and Payment.

B. Geotechnical Testing Agency Qualifications: An independent testing agency (with a Geotechnical engineer licensed in the state where the project is being constructed on staff) qualified according to AST E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM 3740 and ASTM E 548.

C. Tolerances: As indicated herein.

D. Testing: Requirements as specified herein.

1.5 SUBMITTALS

A. Notification:

1. Notify and provide data to regulatory authorities and A/E prior to commencement of work.
2. Provide notice of: encounter with unknown utilities; subgrades before filling; areas requiring
3. testing or inspection.

B. Product Data: For the following:

1. Geotextile.
2. Detection Warning Tape.

C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D2487 of each on site and borrow soil material proposed for fill and backfill.
2. Laboratory compaction curve according to ASTM D1557 for each on site and borrow soil material proposed for fill and backfill.
3. Field reports; in-place soil density tests.
4. One optimum moisture – maximum density curve for each type of soil encountered.
5. Report of actual unconfined compressive strength and/or results of testing tests for each strata tested.
6. Test reports must be submitted daily to the Architect and Owner.

1.6 PROJECT CONDITIONS

A. Subsurface Conditions: Subsurface soils investigations have been made at the site. The report and logs of the test borings and test pits are included in the Appendix of these specifications. Such investigations have been made for the purposes of design only and neither the Engineers, the Owner, nor the Geotechnical Engineer guarantee adequacy or accuracy of the data, or that data are representative of all conditions to be encountered. Such information is made available for general information only and shall not relieve the Contractor of the responsibility for making his own investigations, tests, and analysis. Any additional test borings and other exploratory operations may be made by Contractor shall be at no cost to Owner.

1. See Geotechnical Engineering Report prepared by Hillis Carnes Engineering Associates, Inc. in Division 1 for test boring data and other requirements.

B. Erosion and sediment control, in addition to erosion control specified in Section 31100 and Division 1:

1. Standards: Comply with the requirements of the "Standards and Specifications for Soil Erosion and Sediment Control in Developing Areas" by the U.S.D.A. Soil Conservation Service.
2. General Erosion: Prevent erosion of earthwork; repair and correct any ditches, gullies or erosion immediately and upon occurrence.
3. Excavations: Prevent water from flowing into open excavations and toward building walls.
4. Slopes: Cover (with continuous plastic membrane) and stake all slopes steeper than 1.5 horizontal to 1 vertical.

C. Environmental Conditions:

Do not apply soil treatment when temperature is at or below freezing or when ground is frozen or frost is expected.
2. Do not apply soil treatment when surface water is present.

D. Existing Conditions: Accept the site in the condition which it exists at the time of the award of the contract and perform all work to the grades indicated.

1. Protect plant material, lawns and other features not designated for removal.
2. Protect bench marks, existing structures, fences, sidewalks, paving and curbs from excavating equipment and vehicular traffic.

E. Existing Utilities: Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of protection during earthwork operations.

1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility Owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility Owner.
2. Do not interrupt existing utilities serving facilities occupied and used by others, except when permitted in writing by A/E and then only after acceptable temporary utility service has been provided. Provide a minimum of 48 hour notices to utility Owners and receive written notice to proceed before interrupting any utility.

F. Rock Excavation: Rock excavation may be performed with hoe rams, jack hammers or any method the Contractor wishes to employ except for explosives.

1.7 PROTECTION

A. Safety: Provide protective measures necessary for the safety of workmen, the public and adjacent property. Prevent cave-ins, collapse of walls, structures and slopes both on and adjacent to the site.

B. Standards: Comply with regulations of local authorities having jurisdiction, including all applicable O.S.H.A. requirements.

C. Repair: Includes the removal and replacement with new materials all materials so affected by settlement.

PART 2 - PRODUCTS

2.1 FILL AND BACKFILL

A. Satisfactory Soils:

1. Compacted fill and backfill shall be free of deleterious matter such as frozen materials, organics, wood, debris, or rock larger than 4 inches in diameter and be classified SP, SW, SM, SC, GP, GC, GM, or CW per ASTM D 2487. All material shall have a liquid limit and plasticity index not exceeding 40 and 20 respectively when tested in accordance with ASTM D-4318.
2. The minimum dry unit weight shall not be less than 105 PCF maximum dry density as determined by ASTM D-1557, modified proctor.
3. All fill and backfill materials shall be obtained from on site or from off site sources and shall be approved by the Geotechnical Engineer prior to placement.
4. Provide borrow soil materials when sufficient satisfactory soil materials are not available from site excavations.

B. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with a least 90 percent passing a 1 ½ inch sieve and not more than 12 percent passing a No. 200 sieve.

1. Locations: All on site fill areas

C. Structural Fill: On-site soils free of organic material, topsoil, miscellaneous fill, debris and rock fragments in excess of 3 inches in their largest dimension may be suitable as structural fill. The granular on-site soils may be suitable for re-use as structural fill. Some of these soils have an in-situ moisture content that exceeds the typical range that would allow the recommended compaction to be achieved. Therefore, drying of these soils may be required to achieve the recommended compaction.

If sufficient quantities of suitable on-site soils are not available for structural fill, imported borrow consisting of predominately granular soils conforming to the requirements of the Delaware Department of Transportation Standard Specifications Select Borrow, Type G should be utilized or AASHTO SP-57 stone.

D. Drainage fill:

1. Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel, (ASTM D 448 Coarse - aggregate grading size 57), with 100% passing of 1-1/2" sieve and not more than 5% passing a No. 8 sieve. Aggregate shall meet DELDOT specification for No. 106A aggregate. Provide by Contractor from off site source.

a. Locations: All concrete slab on grade areas

2. For foundation drainage, use aggregate meeting DELDOT specification for No. 3 aggregate.

a. Locations: Drainage fill behind basement walls and retaining walls.

E. Stone Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand (ASTM D2490) with at least 95% passing a 1 ½" sieve and not more than 8% passing a No. 200 sieve. Provide by contractor from off site sources.

F. Subbase Material: Designation CR-6 in accordance with DELDOT specifications.

1. Locations: All vehicular traffic and pedestrian areas

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; except with 100 percent passing a 1 inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve. For utility installations, bedding shall conform to AASHTO #57 stone.

H. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; AASHTO M-43, size No. 17.

I. Sand: ASTM C33; fine aggregate, natural, or manufactured sand.

J. Processed Rubble Fill: Existing brick and concrete rubble, free of wood and steel may be processed by use of tracked equipment such that no particle size greater than 6 inches in the longest dimension remains.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 FILL AND BACKFILL FOR UTILITIES

A. Backfill: Earth removed from the trench provided that in the opinion of Soils Engineer such excavated material is satisfactory for backfilling.

B. Should the excavated material be considered unsatisfactory for backfilling, the Contractor shall remove and dispose of such unsatisfactory material and substitute, in lieu thereof, suitable material obtained from elsewhere on or off the site.

C. Materials shall meet the requirements specified in paragraph 2.1.A above.

2.3 TOPSOIL

A. Refer to Section 329200 Turf and Grasses.

2.4 SOIL TREATMENT - TERMITE CONTROL

A. Emulsion soil chemicals of only water-based type. Do not use any fuel oil as a diluent.

B. Solutions and chemicals listed and approved by EPA, USDA, and Delaware State Departm[illegible] Agriculture.

C. Chemicals used in retreatment shall also be certified and state type of chemical and rate [illegible] tion.

2.5 ACCESSORIES

A. Detectable Warning Tape: Acid and alkali-resistant polyethylene film warning [illegible]e m[illegible]ufactured for marking and identifying underground utilities, a minimum of 6 inch[illegible]m) [illegible] and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utili[illegible] with met[illegible]c core encased in a protective jacket for corrosion protection, detectable by metal de[illegible]or when[illegible]e is buried up to 30 inches (750 mm) deep; colored as follows:

1. Red: Electric
2. Yellow: Gas, oil, steam, and dangerous ma[illegible]ials.
3. Orange: Telephone and other communica[illegible]s.
4. Blue: Water systems
5. Green: Sewer systems.

2.6 GEOTEXTILES

A. Subsurface Drainage Geotextile: [illegible]ven needle-punched geotextile, manufactured for subsurface drainage applications, mad[illegible] poly[illegible]fins or polyesters; with elongation greater than 50 percent; complying with AASH[illegible] M 28[illegible]d th[illegible]ollowing, measured per test methods referenced:

1. Survivabil[illegible]y: [illegible]ss 2; AA[illegible]HTO M 288.
2. Grab Te[illegible]ile Stre[illegible] lbf; ASTM D 4632.
3. Sew[illegible]eam St[illegible]ngth: 142 lbf; ASTM D 4632.
4. Tear [illegible]ns[illegible] 56 lbf; ASTM D 4533.
5. Punctu[illegible]rength: 56 lbf; ASTM D 4833.
6. Apparent [illegible]ning Size: No. 70 sieve, maximum; ASTM D 4751.
7. Permittivity: 0.5 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

B. Separa[illegible] Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 247 lbf; ASTM D 4632.
3. Sewn Seam Strength: 222 lbf; ASTM D 4632.
4. Tear Strength: 90 lbf; ASTM D 4533.
5. Puncture Strength: 90 lbf; ASTM D 4833.
6. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.7 FLOWABLE FILL

A. Stabilized flowable fly ash mixture with a maximum slump of 8" and a minimum unconfined compressive strength of 100 psi used to fill construction excavations.

B. Manufacturer: American Stone Mix or approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify existing ground surfaces have been stripped of topsoil, root mat and existing pavement, unsatisfactory soils, concrete spoil, obstructions and deleterious material.

B. Following rough grading and prior to foundation excavation, placement of fill, or construction of the floor slabs, it is recommended that the exposed subgrade be proofrolled. The proofrolling should be performed using a minimum 10-ton vibratory roller in the presence of the qualified soils technician working under the supervision of a geotechnical engineer. Yielding or otherwise unsuitable subgrade conditions encountered within the proposed building areas should be undercut to firm subgrade conditions and backfilled with compacted structural fill.

C. Locate underground utilities in areas of work. If utilities are to remain in place, provide adequate means of protection during earthwork operations. Contact "Miss Utility".

D. Use of explosives will not be permitted, unless approved by Owner in writing and Regulatory Agencies having jurisdiction.

E. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

F. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

G. Protect subgrade and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

H. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.2 EXCAVATION

A. Excavation consists of removal and disposal of material encountered when establishing required finish grade elevations.

B. Unauthorized Excavations:

1. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of A/E. Unauthorized excavation, as well as remedial work directed by A/E, shall be at Contractor's expense.
2. Under footings, foundations, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing to excavation bottom, without altering required top elevation. Lean concrete, flo-ash fill, or compacted structural fill may be used to bring elevations to proper position, when acceptable by A/E.

C. Additional Excavation: When excavation has reached required subgrade elevations, notify Soils Engineer who will make an inspection of conditions.

1. If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations deeper and replace excavated materials as directed by A/E
2. Removal of unsuitable material below the subgrade elevation and its replacement as directed wi be paid by the Owner on basis of contract conditions relative to change in work.

D. Stability of Excavations: Slope sides of excavations to comply with local codes and ordina having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or bility materials excavated.

1. Maintain sides and slopes of excavations in safe conditions until comple back ng.

E. Shoring and Bracing: Provide materials for shoring and bracing, such as sh piling, u ghts, stringers, and cross braces, in good serviceable condition.

1. Establish requirements for trench shoring and bracing to mply wit cal, State & Federal codes and authorities having jurisdiction.
2. Maintain shoring and bracing in excavations regardl of th perio excavations will be open. Carry down shoring and bracing as excavation progres

F. Dewatering: Prevent surface water and subsurface or gro water om flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavatio Remove water to prevent softening of foundation bottoms, undercutti otings, and soil changes detrimental to stability of subgrades and foundations. Excavatio shall e kept free of water for a minimum of two (2) inches below subgrade of excavation. ovide maintain pumps, well points, sumps, suction and discharge lines, and other dewatering components necessary to convey water away from excavations.
2. Convey water remo from e vations and rain water into approved sediment control devices. Establish and ma tain te porary rainage ditches and other diversions outside excavation limits for each structu . Do not trench excavations as temporary drainage ditches.
3. Excessive grou water con tions: Refer to Article 4.3.6 of the General Conditions.

G. Material Sto ge: Sto pile satisfactory excavated materials where directed, until required for backfill or fill. Place, g le a shape stockpiles for proper drainage.

1. Prevent sa tion of soil above the optimum moisture content.
2. Locate and retain soil materials away from edge of excavations.
3. Dispose of excess soil material and waste materials as herein specified.

H. Excava for Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10', and extending sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. In excavating for footings and foundations, take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. If in excavating for building foundations the soil directly below the building foundations is disturbed, the disturbed soil shall be removed and shall be recompacted to 95% compaction or replaced with concrete backfill.

I. Excavation for Stone and Concrete Pavements: Cut surface under pavements to comply with cross sections, elevations and grades as shown:

1. Where rock or concrete spoil is encountered, carry excavation 18" below subgrade and backfill with suitable material approved by the A/E.

J. Excavation for Trenches: Dig trenches to the uniform width required for particular item to be installed with ample working room.

1. Excavate trenches to depth, lines, gradients, and elevations indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter, keep bottoms of trenches sufficiently below finish grade to avoid freeze
2. Where rock is encountered, carry excavation 6" below required elevation and backfill with a layer of crushed stone or gravel prior to installation of pipe.
3. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.

a. For pipes and conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
b. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.

4. Backfill trenches with concrete where trench excavations are within 18" of column or wall footings and which are carried below bottom of such footings or which pass under wall footings. Place concrete to level of bottom of adjacent footing. Concrete is specified in Division 3.
5. Do not backfill trenches until tests and inspections have been made and backfilling authorized by A/E. Use care in backfilling to avoid damage or displacement of pipe systems.

K. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F. (1 degree C).

L. Ground Surface Preparation (Structural and Pavement areas):

1. The existing ground surface in the structural and pavement areas shall be stripped of topsoil, root mat, existing pavements, unsatisfactory soils, concrete spoil, obstructions and deleterious material. Base course material from the existing pavements may remain if approved by the A/E. The entire area shall be proofrolled, a minimum of four (4) passes, with a loaded dump truck with a minimum axle load of 10 tons in the presence of the soils engineer. Soft spots identified by the Soils Engineer during proofrolling will be undercut and backfilled in accordance with Section 3.4. Proofrolling and compaction equipment shall meet the requirements of Section 3.3.D. Undercutting and backfilling operations for eliminating soft spots above the subgrade elevation shall be included in the base bid.
2. In cut areas, prior to the construction of paving or concrete slab on grade, the entire subgrade shall be proofrolled in the presence of the Soils Engineer. Soft areas encountered during proofrolling shall be undercut and backfilled in accordance with section 3.4. Proofrolling and compaction equipment shall be in compliance with Section 3.3 D. The cost of undercutting and backfilling above the subgrade elevation shall be included in the base bid.

Earthwork Quantities:

1. Contractor shall be responsible for determining earthwork quantities for the completion of the work.

3.3 COMPACTION

A. General: Control soil compaction during construction providing percentage of dry density specified for each area classification.

B. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of the maximum dry density which is determined in accordance with ASTM D 1557, or in accordance with ASTM D 2049 for soils which will not exhibit a well defined moisture density relationship.

1. Structural, pavement and walkway areas, steps and utility trenches - 95% of the maximum dry density.
2. Lawn areas outside the designated structural fill limits – minimum compaction 83% of the maximum dry density and maximum compaction of 88% of the maximum dry density.

C. Moisture Control: Obtaining a uniformly high degree of compaction requires control over the moisture content of the material being placed in the fills and backfill. The soils used in fill and backfill shall be brought to within 3% of optimum moisture at no additional cost to the Owner.

1. Where the soil layer is too dry, the Contractor shall apply water uniformly using approved equipment to increase the moisture content to within 3% of the optimum, taking precautions to prevent free water from appearing on the surface during or subsequent to compaction operations.
2. Where the soil layer is too wet, the Contractor shall dry the soil by blowing, discing to aerate the soil and reduce the moisture content to within 3% of the optimum.

D. Compaction equipment shall be as required to complete the scope of work outlined in the geotechnical report, contract documents and specifications for this project.

3.4 BACKFILL AND FILL

A. General: Place acceptable soil material in layers not more than eight (8) inches in thickness to required subgrade elevations, for each area classification listed below. Each layer shall be compacted to the requirements of Section 3.3B.

1. Fill and backfill within building and pavement limits and in utility trenches shall be structural fill soils meeting the requirements of Section 2.1.A.
2. Under lawn areas outside the designated structural fill limits, backfill and fill soils shall be soils meeting the requirements of Section 2.1.A, or other on site materials approved by the Geotechnical Engineer.
3. Fill and backfill located below walkways and steps shall be constructed of structural fill soils meeting the requirements of Section 2.1.A.
4. Drainage fill material shall be proof rolled to a uniform stable condition prior to placement of vapor retarder.
5. Stone base course shall be compacted to 95% maximum dry density per ASTM D-1557.

B. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Acceptance of construction below finish grade including, where applicable, subdrainage damp proofing, waterproofing, and perimeter insulation.
2. Concrete and masonry have cured 28 days and is adequately braced.
3. Inspection, testing, approval, and recording locations of underground utilities.
4. Removal of concrete formwork.
5. Removal of trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

C. Ground surface preparation: Shall be in accordance with Section 3.2K.

1. When existing ground surface has density less than that specified under Section 3.3B for particular area classification, break up ground surface, pulverize, moisture condition to optimum moisture content, and compact to required depth and percentage of maximum dry density.

D. Placement and Compaction: Place backfill and fill materials in layers not more than 8" in loose depth, for material compacted by heavy compaction equipment and not more than 4" in loose depth for material compacted by hand operated tampers.

1. Before compaction, moisten or aerate each layer as may be necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density for each classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
2. Place backfill and fill materials evenly adjacent to structures, to required elevations. Take care to prevent wedging action of backfill against structures by carrying material uniformly around structure to approximately same elevation in each lift.
3. Structural fill shall extend a minimum of five (5) feet beyond building and road pavement limits and shall include the support slopes to their full width.
4. Backfilling against pipe structures, whose joints involve the use of cement mortar or other concrete, or where buttresses are constructed, shall not be done until mortar has set at least 12 hours.
5. Compaction over one foot above the pipe shall be done with hand mechanical tampers. Compaction density shall be as specified in Section 3.3.

E. Utility trench backfill

1. Place and compact initial backfill of subbase material, free of particles larger than 1 inch, to a height of 12 inches over the utility pipe or conduit. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.
2. Coordinate backfilling with utilities testing.
3. Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installation and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.
4. Fill voids with approved backfill materials while shoring, bracing, and sheeting is removed.
5. Place and compact final backfill of satisfactory soil material to final subgrade.
6. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.5 ROUGH GRADING

A. General:

1. Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surfaces with specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades. In fill areas, sloped surfaces steeper than 5 horizontal to 1 vertical shall be benched so that fill materials will be placed on a level surface. All fill subgrades shall be observed by the Geotechnical Engineer.
2. Adjacent grading transition areas shall be graded in a manner to maintain positive drainage, even if not shown to be within the designated “Limit of Disturbance” line. Notify the A/E if discrepancies are encountered and significant grading is necessary. Grading necessary for slope tie ins, utility installations and other items shown to be installed are included in the base bid.

B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes, and as follows:

1. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10' above or below required subgrade elevations.
2. Walks: Shape surface or areas under walks to line, grade and cross section, with finish surface not more than .04' above or below required subgrade elevation.

3. Pavements: Shape surface areas under pavement to line, grade and cross section, with finish surface not more than .04' for bituminous surfaces and 08' for stone surfaces, above or below required subgrade elevation.

C. Grading Surface or 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 .02' when tested with a straightedge.

3.6 BUILDING SLAB BASE COURSE

A. General: Slab base course consists of placement of drainage fill or stone base course material, in layers of indicated thickness, over subgrade surface to support concrete building slabs.

B. Placing: Place slab base course on prepared subgrade in layers of uniform thickness, conforming to indicate cross section and thickness. Maintain optimum moisture content for compacting material during placement operations.

1. When a compacted drainage course is shown to be 6" thick or less, place material in a single layer. Where shown to be more than 6" thick, place material in equal layers, except no single layers more than 6" or less than 3" in thickness when compacted.

C. Any ruts or soft yielding spots which may occur or areas that have inadequate compaction or deviations from the requirements set forth herein shall be corrected by removing and adding uniformly graded crushed stone or by loosening crushed gravel, reshaping and recompacting. The subgrade shall have a uniform density throughout its entire depth and width and shall be approved by the A/E prior to pouring any concrete.

D. Following this preparation, the subgrade shall be protected from damage as described below:

1. The subgrade shall be protected from damage by heavy loads or equipment moving on tracks or cleats.
2. The contractor shall at all times keep the subgrade drained.
3. No concrete shall be deposited upon a frozen subgrade nor, until the subgrade has been approved by the A/E.
4. Immediately in advance of placing concrete, the subgrade shall be sprinklered with as much water as it can readily absorb.

3.7 FINISH GRADING & PLACING TOPSOIL

A. Refer to Specification Section 329200 – “Turf and Grasses”

3.8 MAINTENANCE

A. Protection of graded areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris. 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, reshape, and compact to required density prior to further construction.

C. Restore areas previously occupied by stockpiled materials to match finished condition of the remainder of the work.

3.9 APPLICATION OF SOIL TREATMENT

A. Refer to Section 313116 Termite control

3.10 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Removal from Owner's Property: Remove waste materials including trash, debris, and unsuitable and excess excavated material, and dispose of off Owner's property.

3.11 FIELD QUALITY CONTROL – SOILS

A. Quality Control Testing During Construction: Allow testing service to inspect and approve subgrades and fill layers before further construction work is performed.

1. Perform field density tests in accordance with ASTM D 1556 (sand cone method) or ASTM D 2922 and D-3017(shallow depth nuclear method), as applicable.
2. Paved Areas and Building Slab Subgrade: Make at least one field density test of subgrade for every 2,000 sq. ft. of paved area or building slab area, but in no case less than 3 tests. In each compacted fill layer, make one field density test for every 2,000 sq. ft. of overlaying building slab or paved area, but in no case less than 2 tests. Field density tests shall be made at all walkway entrances and ramps into the proposed building.
3. Foundation Wall Backfill: Take enough field density tests to ensure backfill is being properly compacted.
4. Utility Trench Backfill: Perform field density tests on a spot-check basis to assist the Contractor in determining if compaction is in accordance with the specifications.
5. If in opinion of A/E, based on testing service reports and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction and testing at no additional expense.
6. Footing Subgrade: For each strata of soil on which footings will be placed, conduct at least one test to verify required design bearing capacities. Subsequent evaluation and approval of each footing subgrade should be performed by Geotechnical Testing Agency.
7. Costs for testing and inspection shall be borne by the Contractor.

3.12 FIELD QUALITY CONTROL - SOIL TREATMENTS

A. Pay costs for required testing of termite control materials. Samples shall be taken and analyzed by an independent testing laboratory.

B. Sampling: Test one sample of working solution for each 10,000 square feet of area applied. Take samples from discharge end of spraying equipment for each batch mixed and applied if less than 10,000 square feet.

C. Retreating: Retreat all areas if the test results average less than 90 percent of listed minimum concentration.

3.13 TESTING AND INSPECTION

A. INSPECTION AGENCY: Construction Manager will employ an Independent Testing agency for purposes of inspecting and testing construction of embankments, fills, backfills, trenches, and subgrades and report to the A/E conformance in all particulars to specification requirements.

B. Scheduling:

1. Assign qualified personnel to be on site at all times when operations are scheduled.
2. The Contractor should note that no earthwork operation shall be permitted in their absence.

C. Responsibilities:

1. Evaluation of subgrade preparation and suitability.
2. Moisture content and field density tests on all layers of fill and backfill material pla
3. Evaluation of degree of compaction attained for all fill and backfill material placed.
4. Testing and evaluation of borrow material.
5. Sources of borrow and of select fill.
6. Footing subgrade suitability.
7. Inspection of installation of Subdrainage system.

D. Results of Tests:

1. Make results available to the Soils Engineer and A/E imm iately up completion of areas of layers.

E. Final Report: The Inspection Agency shall prepare a written r t tha marizes the work inspected during the course of the project. A discussion of all d ons fr the contract documents and specifications, with their related impact on the fin const n, sh l be described in detail. The engineer of record shall review this final report, d rec ime corrective measures (as deemed necessary) that must be made prior to final accepta of the ork. Prior to final payment, a written report certifying that the work meets the requirements th contract documents, specifications, and all governing agencies shall be prepared, s itted, and app oved by the A/E.

END OF SECTION 312000

SECTION 312319 - DEWATERING

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 construction dewatering.

B. Related Sections include the following:

1. Division 01 Section "Temporary Construction Utilities, Facilities and Controls" for temporary utilities and support facilities.
2. Division 31 Section "Earth Moving" for excavating, backfilling, site grading and for site utilities.
3. Division 31 Section "Excavation Support and Protection.

1.3 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control groundwater flow into excavations and permit construction to proceed on dry, stable subgrades.

1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
2. Prevent surface water from entering excavations by grading, dikes, well pointing or other means.
3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
4. Remove dewatering system if no longer needed.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

B. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.5 PROJECT CONDITIONS

Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Construction Manager and then only after arranging to provide temporary utility services according to requirements indicated.

Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
2. The geotechnical report is included elsewhere in the Project Manual.

C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During dewatering, regularly resurvey benchmarks , maintaining an accurate log of survey elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

1. Maintain piezometric water level below surface of excavation.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids

inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.3 OBSERVATION WELLS

A. Provide, take measurements, and maintain at least the minimum number of observation wells or piezometers indicated and additional observation wells as may be required by authorities having jurisdiction.

B. Observe and record daily elevation of ground water and piezometric water levels in observation wells.

C. Repair or replace, within 24 hours, observation wells that become defective, damaged, or destroyed. Suspend construction activities in areas where observation wells are not functioning properly until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.

1. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

END OF SECTION 312319

SECTION 313116 - TERMITE CONTROL

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. Soil treatment with termiticide.

B. Related Sections include the following:

1. Division 06 Section "Rough Carpentry" for wood preservative treatment by pressure process.
2. Division 07 Section "Sheet Metal Flashing and Trim" for custom-fabricated metal termite shields.

1.3 PERFORMANCE REQUIREMENTS

A. Service Life of Soil Treatment: Soil treatment by use of a termiticide that is effective for not less than 10 years against infestation of subterranean termites.

1.4 SUBMITTALS

A. Product Data: For termiticide borate and mesh barrier system.

1. Include the EPA-Registered Label for termiticide and borate products.

B. Product Certificates: For termite control products, signed by product manufacturer.

C. Qualification Data: For firms of termite control products.

D. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's record information, including the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Brand name and manufacturer of termiticide.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes, and rates of application used.
6. Areas of application.
7. Water source for application.
8. Areas of application.

E. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located, and who employs workers trained and approved by bait-station system manufacturer to install manufacturer's products.

B. Regulatory Requirements: Formulate and apply termiticides according to the EPA-Registered Label.

C. Source Limitations: Obtain termite control products from a single manufacturer for each product.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination" to schedule application of termiticide products.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: To ensure penetration, do not treat soil that is frozen, water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.

1.7 COORDINATION

A. Coordinate soil treatment application with excavating, backfilling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

B. Apply borate treatment after framing, sheathing, and exterior weather protection is completed but before electrical and mechanical systems are installed.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

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

1.9 MAINTENANCE SERVICE

A. Continuing Service: Beginning at Substantial Completion, provide 12 months' continuing service including monitoring, inspection, and re-treatment for occurrences of termite activity. Provide a standard continuing service agreement. State services, obligations, conditions, and terms for agreement period; and terms for future renewal options.

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:

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

1. Termiticides:

a. Aventis Environmental Science USA LP; Termidor.
b. Bayer Corporation; Premise 75.
c. Dow AgroSciences LLC; Dursban TC Equity.
d. FMC Corporation, Agricultural Products Group; Talstar Pre[illegible]FT Torpedo.
e. Syngenta; Demon TC.

2.2 SOIL TREATMENT

A. Termiticide: Provide an EPA-registered termiticide complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil surfaces with earthwork, slab and foundation work, landscaping, and other conditions affecting performance of termite control.

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

3.2 PREPARATION

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparation before beginning application of termite control treatment. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

3.3 APPLICATION, GENERAL

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

3.4 APPLYING SOIL TREATMENT

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.

1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
2. Foundations: Adjacent soil including soil along the entire inside perimeter of foundation walls, along both sides of interior partition walls, around plumbing pipes and electrical conduit penetrating the slab, and around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
3. Crawlspaces: Soil under and adjacent to foundations as previously indicated. Treat adjacent areas including around entrance platform, porches, and equipment pads. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
4. Masonry: Treat voids.
5. Penetrations: At expansion joints, control joints, and areas where slab will be penetrated.

B. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

C. Protect termiticide solution, dispersed in treated soils and fills from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-registered Label instructions.

D. Post warning signs in areas of application.

E. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

1. Service Frequency: Inspect monitoring stations no fewer than once every three months.

END OF SECTION 313116

SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes temporary excavation support and protection systems.

B. Related Sections include the following:

1. Division 01 Section "Temporary Construction Utilities, Facilities Contro for temporary utilities and support facilities.
2. Division 31 Section "Earth Moving" for excavating and ba filling for isting utilities.
3. Division 31 Section "Dewatering" for dewatering excav ns.

1.3 PERFORMANCE REQUIREMENTS

A. Design, furnish, install, monitor, and maintain e ava n supp and protection system capable of supporting excavation sidewalls and of resisti soil rostatic pressure and superimposed and construction loads.

1. Contractor is solely responsible for maintenan of excavations and worker safety. Architect, Owner and Construction Man r no liability for excavation support and protection systems.
2. Provide professional engi ering rvices needed to assume engineering responsibility where required, including prepa n o awings and a comprehensive engineering analysis by a qualified professional engine
3. Prevent surface w ente excavations by grading, dikes, or other means.
4. Install excavat n suppo and protection systems without damaging existing buildings, pavements, and her impro ments adjacent to excavation.

1.4 SUBMITTAL

A. Shop Drawi Information: Prepared by or under the supervision of a qualified professional engineer for exc tion support and protection systems.

Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.

Qualific ion Data: For Installer and professional engineer.

C. hotographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site mprovements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent

interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
2. The geotechnical report is included elsewhere in the Project Manual.

C. Survey adjacent structures and improvements, employing a qualified professional engineer and land surveyor; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces is not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

1. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION 315000

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving overlay.
4. Asphalt surface treatments.
5. Pavement-marking paint.
6. Cold milling of existing hot-mix asphalt pavement.

B. Related Sections include the following:

1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.

1.3 DEFINITIONS

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

B. DOT: Delaware Department of Transportation.

1.4 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of Specifications for road and Bridge Construction of the Delaware Department of Transportation.

1. Standard Specification: Division 400
2. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 SUBMITTALS

Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

C. Job-Mix Designs: For each job mix proposed for the Work.

D. Qualification Data: For manufacturer.

E. Material Test Reports: For each paving material.

F. Material Certificates: For each paving material, signed by manufacturers.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. Manufacturer shall be a paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated, as documented according to ASTM E 548.

C. Regulatory Requirements: Comply with Delaware Department of Transportation Specifications for Road and Bridge Construction for asphalt paving work.

D. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

1. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
2. Review condition of subgrade and preparatory work.
3. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement marking material to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp. Adhere to all specifications in Delaware Department of Transportation Specifications for Road and Bridge Construction.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at minimum ambient or surface temperatures specified in the Delaware Department of Transportation Specifications for Road and Bridge Construction.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials: All materials used under this section shall conform to the requirements of Delaware Department of Transportation Specifications for Road and Bridge Construction, including, but not limited to: graded aggregate, asphalt cement, and tack coat.

B. Herbicide Treatment: Commercial chemical for weed control, registered by Environmental Protection Agency. Provide granular, liquid or wettable powder form. Obtain written approval from the Maryland Department of the Environment prior to application of the herbicide.

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

a. Ciba-Geigy Corp.
b. Dow Chemical, USA
c. E.I. Du Pont de Nemours & Co., Inc.
d. FMC Corp
e. Thompson-Hayward Chemical Co.
f. U.S. Borax and Chemical Corp.
g. Allied Chemical Corp.
h. Ag-Chem Products, Inc.

C. Lane Marking Paint: Paint shall comply with Division 700 of the Delaware Department of Transportation Specifications for Road and Bridge Construction.

1. Color: White
2. Color: Yellow
3. Color: Blue

D. Joint Sealants: Joint Sealants shall comply with Delaware Department of Transportation Specifications for Road and Bridge Construction, Divisions 700 & 800.

2.2 MIXES

A. Hot-Mix Asphalt: Provide Plant Mixed, hot-laid, asphalt-aggregate mixture complying with Delaware Department of Transportation Specifications for Road and Bridge Construction, Division 400 and referenced Divisions.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

C. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with if formulated by manufacturer for that purpose.
2. Remove spillages and clean affected surfaces.

D. Proceed with paving only after unsatisfactory conditions have been corrected.

E. Tack Coat: Apply to contact surfaces of previously constructed asphalt or Portland cement concrete and surfaces abutting or projecting into hot-mixed asphalt pavement. Distribute at a rate of 0.05 to 0.15 gal. Per sq. yd. of surface in accordance Section 401 of the Delaware Department of Transportation Specifications for Road and Bridge Construction.

F. Allow to dry until at proper condition to receive paving.

G. Exercise care in applying bituminous materials to avoid smearing of adjacent concrete surfaces. Remove and clean damaged surfaces.

3.2 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of as specified on plans.
2. Mill to a uniform finished surface free of gouges, grooves, and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course where encountered, and keep material separate from milled hot-mix asphalt.
6. Transport milled hot-mix asphalt to asphalt recycling facility.
7. Keep milled pavement surface free of loose material and dust.

3.3 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Pump hot undersealing asphalt under rocking slabs until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Patching: Fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.

E. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.4 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.5 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at minimum temperature of 225 deg F.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Immediately correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.6 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course. Joints shall comply with Delaware Department of Transportation Specifications for Road and Bridge Construction, Section 401.12.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.

6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.7 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 98 percent of reference laboratory density according to AASHTO T 209, but not less than 96 percent nor greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.9 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Contractor shall provide striping on parking and roadway surfaces as indicated on the plans. The following is a list of all required striping:

1. Parking stalls.
2. Cross-hatch/gore areas.
3. Handicap Parking symbols.
4. Stop bars.
5. Directional arrows.
6. Lane lines.
7. Words/numbers.

C. Allow paving to age for 30 days before starting pavement marking.

D. Sweep and clean surface to eliminate loose material and dust.

E. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.10 WHEEL STOPS

A. Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Construction Manager will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.

2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

    a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with n fewer than 3 cores taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear meth according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

F. Remove and replace or install additional hot-mix asphalt where test results or measureme dicate it does not comply with specified requirements.

3.12 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials om Proj site and legally dispose of them in an EPA-approved landfill.

1. Do not allow excavated materials to accumulate on-site.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes exterior cement concrete pavement for the following:

1. Driveways and roadways.
2. Parking lots.
3. Curbs and gutters.
4. Walkways.
5. Unit paver base.

B. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.
2. Division 31 Section "Earth Moving" for subgrade preparation, grading, and subbase course.
3. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants of joints in concrete pavement and at isolation joints of concrete pavement with adjacent construction.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Samples: 10-lbsample of exposed aggregate.

D. Qualification Data: For manufacturer. Manufacturer of ready-mixed concrete products complying with ASTM C94 requirements for production facilities and equipment.

E. Material Test Reports: General contractor will engage a qualified testing agency for indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

F. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

1. Cementitious materials.

2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

G. Field quality-control test reports.

H. For plazas and wide walkways, submit control joint spacing plan for review.

I. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

C. ACI Publications: Comply with ACI 301 "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and qualities standards for materials and execution.

1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than 96 inches by 96 inches
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1. Before submitting design mixtures, review concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and concrete pavement construction practices. Require representatives, including the following, of each entity directly concerned with concrete pavement, to attend conference:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.

c. Ready-mix concrete producer.
d. Concrete pavement subcontractor.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves with 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.

2.3 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

Epoxy-Coated Welded Wire Fabric: ASTM A 884/A 884M, Class A, plain steel.

D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.

F. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.

G. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

H. Plain Steel Wire: ASTM A 82, as drawn.

I. Deformed-Steel Wire: ASTM A 496.

J. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain.

K. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.

L. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain steel bars.

M. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

N. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete with greater compressive strength than concrete, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

O. Epoxy Repair Coating: Liquid two-part epoxy repair coating, compatible with epoxy coating on reinforcement.

P. Zinc Repair Material: ASTM A 780.

2.4 CONCRETE MATERIALS

A. Materials: All materials including but not limited to reinforcing materials, concrete materials, concrete mix, admixtures, curing materials, traffic paint and other related materials used under this section shall conform to the requirements of the Delaware Department of Transportation Specifications for Road and Bridge Construction. References to a required class of concrete shall correspond to the classes as shown in the State of Delaware Department of Transportation Specifications for Road and Bridge Construction Division 500 and Division 800.

B. Fly ash shall meet the approval of the ASTM C-618 pozzolan Class F and may be used as a partial substitute for cement when approved by the Architect.

C. The concrete mix used in performing this work shall be DelDOT Class “A” or DelDOT Class “B” depending on the compressive strength shown on the details and shall meet the approval of the Architect.

D. The concrete temperature shall not exceed 90°F when delivered to the job-site or at any time prior to placement in the forms.

E. Type I - Portland Cement: Shall be used from October 1 through May 1 and when the air temperature in the shade and away from artificial heat is above 70°F or less, or as directed by the Architect.

A. Type II - Portland Cement: Shall be used from May 1 through October 1 and when the air temperature in the shade and away from artificial heat is above 70°F, or as directed by the Architect.

F. When approved by the Architect, Hi-Early strength concrete may be used. Approval will be on a case by case basis.

G. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:

1. Aggregate Sizes: 1/2 to 3/4 inch nominal.
2. Aggregate Source, Shape, and Color: Submit color samples for review by Architect and owner

H. Water: ASTM C 94/C 94M.

I. Air-Entraining Admixture: ASTM C 260.

J. Chemical Admixtures: Admixtures may only be use with prior approval by the Architect. Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 FIBER REINFORCEMENT

A. Synthetic Fiber: fibrillated polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.

1. Available Products:

a. Fibrillated Fibers:

1) Axim Concrete Technologies; Fibrasol F.
2) FORTA Corporation; Forta.
3) Euclid Chemical Company (The); Fiberstrand F.
4) Grace, W. R. & Co.--Conn.; Grace Fibers.
5) SI Concrete Systems; Fibermesh.

2.6 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. 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.

1. Available Products:

a. Axim Concrete Technologies; Cimfilm.
b. Burke by Edeco; BurkeFilm.
c. ChemMasters; Spray-Film.
d. Conspec Marketing & Manufacturing Co., Inc.; Aquafilm.
e. Dayton Superior Corporation; Sure Film.
f. Euclid Chemical Company (The); Eucobar.

g. Kaufman Products, Inc.; Vapor Aid.
h. Lambert Corporation; Lambco Skin.
i. L&M Construction Chemicals, Inc.; E-Con.
j. MBT Protection and Repair, ChemRex Inc.; Confilm.
k. Meadows, W. R., Inc.; Sealtight Evapre.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
n. Sika Corporation, Inc.; SikaFilm.
o. Symons Corporation; Finishing Aid.
p. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

E. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 2, Clas

1. Available Products:

a. Anti-Hydro International, Inc.; AH Curing Compound #2 WP WB
b. Burke by Edoco; Resin Emulsion White.
c. ChemMasters; Safe-Cure 2000.
d. Conspec Marketing & Manufacturing Co., Inc.; W.B sin Cure
e. Dayton Superior Corporation; Day-Chem Whit igme d Cur (J-10-W).
f. Euclid Chemical Company (The); Kurez VOX W Pig d.
g. Kaufman Products, Inc.; Thinfilm 450.
h. Lambert Corporation; Aqua Kure-Whi
i. L&M Construction Chemicals, Inc.; M C e R
j. Meadows, W. R., Inc.; 1200-White.
k. Symons Corporation; Resi-Chem White.
l. Tamms Industries, Inc.; Ho re 200-W.
m. Unitex; Hydro White.
n. Vexcon Chemicals, I , Certi ex Enviocure White 100.

2.7 RELATED MATERIALS

A. Expansion- and Isol on-Joint-f er Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork o elf-expan g cork.

B. Bonding Ag : AST C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bondi dhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bon ng to damp faces, of class suitable for application temperature and of grade to requirements, and a ollows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened crete.

D. hemical Surface Retarder: (For exposed aggregate concrete) Water-soluble, liquid-set retarder with olor dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.

1. Products:

a. Burke by Edeco; True Etch Surface Retarder.
b. ChemMasters; Exposee.
c. Conspec Marketing & Manufacturing Co., Inc.; Delay S.
d. Euclid Chemical Company (The); Surface Retarder S.
e. Kaufman Products, Inc.; Expose.
f. Metalcrete Industries; Surftard.

g. Nox-Crete Products Group, Kinsman Corporation; Crete-Nox TA.
h. Scofield, L. M. Company; Lithotex.
i. Sika Corporation, Inc.; Rugasol-S.
j. Vexcon Chemicals, Inc.; Certi-Vex Envioset.

2.8 WHEEL STOPS

A. Wheel Stops: Solid, 3000 PSI concrete, precast.

1. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.

2.9 ADA TRUNCATED DOMES

A. General: In-line replacable designed to be installed in a “wet set” condition. Units must include anchors which allow replacement by removing colored covers and bolts while leaving anchors in place.

B. Materials: Homogenous glass and carbon reinforced composite

1. UV stable and colorfast.
2. Resistant to slat and chemical staining per ASTM B117 & D1308.
3. Minimum Compressive and Tensile Strength of 28,900 psi and 16,000 psi respectively.
4. Must be able to handle load bearing capacity of 16,000 lbs per AASHO –H20 with no visible damage.
5. Color must be uniform throughout with integral coloring to provide color.
6. Dome geometry must comply with ADA regulations for detectable warnings at curb ramps in diameter, height and spacing.

C. Where installation on radius is shown provide precut and scored units for installation without gaps and piecemeal infills. Field cut rectangular units will not be acceptable.

D. Units shall be by ADA Solutions, Inc. or approved equal.

2.10 CONCRETE MIXTURES

A. The concrete mix used for forming this work shall be DelDOT Class “A” or DelDOT Class “B” depending on the compressive strength shown on the details and shall meet the approval of the Architect.

B. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

C. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 4000 psi or 3000 psi. depending on location
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
3. Slump Limit: 2-5, plus or minus 1 inch.

D. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 6 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.

E. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

F. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture, plasticizing and retarding admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity or other adverse placement conditions.

G. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals. Limits shall be as follows per DelDOT requirements:

1. Fly Ash or Pozzolan: 25 percent.
2. Ground Granulated Blast-Furnace Slag: 50 percent.
3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

H. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd..

2.11 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116 where synthetic fibers are noted on the plans. Furnish batch certificates for each batch discharged and used in the Work.

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 EXAMINATION

A. Examine exposed subgrade and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.
3. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction according to requirements in Division 31 Section "Earth Moving."

C. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides 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.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting 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 reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

A. General: Form 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 steel 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. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   Doweled Joints: Install 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.

C. Isolation 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, unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. All Isolation Joints shall be treated with joint filler.
4. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface.

5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. 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. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicat For larger walkways, width greater than 12' and plazas, submit shop drawing of joint pattern. C strue contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finis each of joint with grooving tool to a 3/8-inch radius. Repeat grooving of con tion joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
2. Doweled Contraction Joints: Install dowel bars and support assemblies ts w indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete onding one side of joint.

E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete a initia floating with an edging tool to a 3/8-inch radius. Repeat tooling of edges after app face ies. Eliminate tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and c te fo work installation, steel reinforcement, and items to be embedded or cast in. Notify other ades mit tallation of their work.

B. Remove snow, ice, or frost from subbase surface and reinf cement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uni m d pened condition at time concrete is placed. Do not place concrete around manholes or oth structu until they are at required finish elevation and alignment.

D. Comply with ACI 301 requi nts f measuring, mixing, transporting, and placing concrete.

E. Do not add water to fr h concrete ter testing.

F. Deposit and sp ad con in continuous operation between transverse joints. Do not push or drag concrete into lace or se vibrators to move concrete into place.

G. Consolidate co te according to ACI 301 by mechanical vibrating equipment supplemented by hand spa g, rodding, amping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal ibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only are-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

H. creed pavement surfaces with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart 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 surface treatments.

J. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

K. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of pa[illegible] machine during operations.

L. 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.

M. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work fr[illegible] 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 mixture designs.

N. Hot-Weather Placement: Comply with ACI 301 and as follows when hot weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. 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 steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and 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. Construct test sections of each type of concrete paving, including at least one expansion joint and control joints, for review by CM, Owner and Architect for agreement of finish prior to starting concrete installation. Review will include texture of broom finish, joint striking, picture framing and geometric conformity.

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. Incorporate “picture framing” of concrete in finish within lump sum prices bid.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. 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.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. 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.
2. 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.

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: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.10 WHEEL STOPS

A. Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded in holes drilled into wheel stops at one-quarter to one-third points. Firmly bond each dowel to wheel stop and to pavement. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Construction Manager shall engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.

a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens 28 days.

    a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Drill test cores, where directed by 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 321313

SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

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. Expansion and contraction joints within cement concrete pavement.

B. Related Sections include the following:

1. Division 07 Section "Concrete Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.
2. Division 32 Section "Concrete Paving" for construction joints in concrete pavement.

1.3 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site in original unopened containers or bundles with labels indicating manufacturer's product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F .
2. When joint substrates are wet or covered with frost.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

2.3 COLD-APPLIED JOINT SEALANTS

A. Type NS Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, nonsag silicone sealant complying with ASTM D 5893 for Type NS.

1. Products:

a. Crafco Inc.; RoadSaver Silicone.
b. Dow Corning Corporation; 888.

2.4 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

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.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of backer materials.
2. Do not stretch, twist, puncture, or tear backer materials.
3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.

D. Install sealants using proven techniques that comply with the following and at the same time backing installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses provided for each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealants from surfaces adjacent to joint.
2. Use tooling agents that are approved in writing by joint sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.

G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the 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 and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.

END OF SECTION 321373

SECTION 321413 – PRECAST CONCRETE UNIT PAVING

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. Concrete Pavers
2. Joint Sand
3. Setting Bed Sand
4. Base Aggregate

1.3 ACTION SUBMITTALS

A. Concrete Paver:
1. Samples for verification: Three representative full-size samples of each paver type, thickness, color and finish that indicate the range of color variation and texture expected upon project completion.
2. Accepted samples become the standard of acceptance for the product produced.
3. Manufacturer's catalog product data, installation instructions, and material safety data sheets for the safe handling of the specified materials and products.

B. Setting Bed Sand:
1. Provide three representative one pound samples in containers of setting bed Sand materials.

C. Polymeric Joint Sand:
1. Samples for Initial Selection: Provide three representative samples in containers of Polymeric Joint Sand material, cured and dried, for color selection.

D. Paving Installation Contractor:
1. Job references from a minimum of three projects similar in size and complexity. Provide Owner/Client/General Contractor names, postal address, phone, fax, and email address.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

1.5 FIELD CONDITIONS

A. Environmental Requirements:
1. Install Concrete Pavers only on unfrozen and dry Setting Bed Sand.
2. Install Setting Bed Sand only on unfrozen and dry Base or Subbase Aggregate materials.
3. Install Base or Subbase Aggregates only over unfrozen subgrade.

4. Install Setting Bed Sand or Concrete Pavers when no heavy rain or snowfall are forecast within 24 hours.

PART 2 - PRODUCTS

2.1 CONCRETE PAVERS

A. Basis-of-Design Product: The Concrete Paver shapes are based on:

1. Unilock:
   a. Promenade Plank Paver
2. As manufactured by:
   a. Unilock, 229 County Rd 541, Lumberton, NJ 08048
   b. Contact: Jason Prieto, 571-775-9245, Jason.prieto@[illegible]
3. The specified products establish minimum requirements that substitutions must meet to be considered acceptable.

2.2 ACCESSORIES

A. Cork Joint Filler: Preformed strips complying with ASTM D1752, Type II.

B. Compressible Foam Filler: Preformed strips complying with ASTM D1056, Grade 2A1.

2.3 JOINT SAND

A. Polymeric Joint Sand:
1. Provide Polymeric Joint Sand as manufactured by:
   a. Alliance Gator G2
      1) Product Type: Dry mix, contains polymeric binding agent, activated with water.
      Color: (Insert color Beige, Slate Grey, Ivory or Black Diamond) (Check local color availability)
   b. Techniseal HP Polymeric Max Sand
      1) Product Type: Dry mix, contains polymeric binding agent, activated with water.
      2) Color: (Insert color Grey, Tan or custom)
   c. Provide Polymeric Joint Sand meeting the minimum material and physical properties as follows:
      1) Compression Strength: proven resistance to compression of 550 PSI after drying for 7 days under controlled conditions (73°F (23°C) at 50% humidity).
         a) Test sand sample shape: cylinder (2” (5 cm) dia. X 4” (10 cm) high).

2.4 AGGREGATE SETTING-BED MATERIALS

A. Graded Aggregate for Base: Sound, crushed stone or gravel complying with ASTM D448 for Size No. 8.

B. Sand Setting Bed:
1. Provide Setting Bed Sand as follows:
   a. Washed, clean, non-plastic, free from deleterious or foreign matter, symmetrically shaped, natural or manufactured from crushed rock.

b. Do not use limestone screenings, stone dust, or sand material that does not conform to conform to the grading requirements of ASTM C 33.
c. Do not use mason sand or sand conforming to ASTM C 144.4. Utilize sands that are as hard as practically available where concrete pavers are subject to vehicular traffic

C. Drainage Geotextile: Nonwoven needle-punched geotextile fabric, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2, AASHTO M 288.
2. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum; ASTM D4751.
3. Permittivity: 0.5 per second, minimum; ASTM D4491.
4. UV Stability: 50 percent after 500 hours' exposure, ASTM D4355.

D. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Replace Concrete Pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.

B. Mix Concrete Pavers from a minimum of three (3) bundles simultaneously drawing the paver vertically rather than horizontally, as they are placed to produce uniform blend of colors and textures. (Color variation occurs with all concrete products. This phenomenon is influenced by a variety of factors, e.g. moisture content, curing methods, different aggregates and, most commonly, from different production runs. By installing from a minimum of three (3) bundles simultaneously, variation in color is dispersed and blended throughout the project.

C. Exercise care in handling and mix concrete pavers to prevent surfaces from contacting backs or edges of other units.

D. Provide Concrete Pavers using laying pattern as indicated. Adjust laying pattern at pavement edges such that cutting of edge pavers is minimized. Cut all pavers exposed to vehicular tires no smaller than one-third of a whole paver.

E. Use string lines or chalk lines on Setting Bed Sand to hold all pattern lines true.

F. Set paver surface elevation a minimum of 3 mm (1/8 inch) to a maximum of 6 mm (1/4 inch) above adjacent drainage inlets, concrete collars or channels (provided the change in slope does not impede or alter the drainage or direction of flow).

G. Place units hand tight against spacer bars. Adjust horizontal placement of laid pavers to align straight.
1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

H. Provide space between paver units of 1/32in. (1 mm) wide to achieve straight bond lines.

I. Prevent joint (bond) lines from shifting more than ±1/2 in. (±13mm) over 50 ft. (15 m) from string lines.

J. Fill gaps between units or at edges of the paved area that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size unit pavers.

K. Cut Concrete Pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

L. Prevent all traffic on installed Concrete Pavers until Joint Sand has been vibrated into joints. Keep skid-steer and forklift equipment off newly laid Concrete Pavers that have not received initial compaction and Joint Sand material.

M. Vibrate Concrete Pavers into leveling course with a low-amplitude plate vibrator capable of 3500 to 5000-lbf (22-kN) compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:
1. After edge pavers are installed and there is a completed surface course before surface is exposed to rain.
2. Compact installed Concrete Pavers to within 6 feet (2 meters) of the laying face before ending each day's work. Cover Concrete Pavers that have not been compacted and leveling course on which pavers have not been placed, with non-staining plastic sheets to prevent Setting Bed Sand from becoming disturbed.

N. Protect face mix Concrete Paver surface from scratching, staining during compaction by utilizing a urethane pad.

O. Remove any cracked or structurally damaged Concrete Pavers and replace with new units prior to installing Joint Sand material.

P. Joint Pattern: Running bond as indicated.

Q. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler board backing for sealant-filled joints [unless otherwise indicated; where unfilled joints are indicated, provide temporary filler until paver installation is complete]. Install joint filler before setting pavers. Sealant materials and installation are specified in Section 079200 "Joint Sealants."

R. Expansion and Control Joints: Provide cork joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.

S. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

3.3 FIELD QUALITY CONTROL

A. Verify final elevations for conformance to the drawings after sweeping the surface clean.1.Prevent final Concrete Paver finished grade elevations from deviating more than ±3/8 in. (±10 mm) under a 10 ft (3 m) straightedge or indicated slope, for finished surface of paving.

B. Lippage: Paver-to-Paver Lippage:
1. No greater than 3 mm (1/8 inch) difference in height between adjacent pavers

3.3 REPAIRING, CLEANINGAND SEALING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Cleaning: Remove excess dirt, debris, stains, grit, etc. from exposed paver surfaces; wash and scrub clean.
   1. Clean Concrete Pavers in accordance with the manufacturer's written recommendations

END OF SECTION 321413

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SECTION 321813 - SYNTHETIC GRASS SURFACING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, equipment, and materials, and do work necessary for the removal of the existing synthetic turf at the Middle School Stadium to install a new synthetic turf surface, as indicated on the Drawings and as specified. Work shall include but shall not be limited to:

1. Synthetic surface including all inlays and lines/markings and related finish work.
2. Installation of perimeter anchor systems.

1.2 RELATED SECTIONS

A. Review Contract Documents for requirements that affect work of this section. Specification Sections that directly relate to work of this section include, but are not limited to:

1. Section 321313 – Concrete Paving
2. Section 334200 – Synthetic Turf Subdrainage
3. Section 323113– Chain Link Fences and Gates
4. Section 334200 – Stormwater Conveyance
5. Section 312000 – Earth moving

1.3 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirement shall govern.

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. T 89 - Determining the Liquid Limit of Soils.
   b. T 90 - Determining the Plastic Limit and Plasticity Index of Soils.
2. Occupational Safety and Health Administration (OSHA).
3. Department of Transportation Standard Specifications.
4. American Society for Testing and Materials (ASTM):
   a. D 395 - Rubber Property – Compression Test.
   b. D 418 - Pile Height, Tuft Spacing, Face Weight and Total Weight
   c. D1335 – Tuft Bind.
   d. D1682 – Grab Tear Strength.
   e. D 2256 - Breaking Load (Strength) and Elongation of Yarn by the Single-Strand Method.
   f. F 355 - Shock Absorbing Properties of Playing Surface Systems and Materials.
   g. F 1551 – Water Permeability
5. NFHS - National Federation of High School Associations, Rules and Regulations, current edition.

1.4 DEFINITIONS

A. Excavation: Removal of material encountered to subgrade elevations indicated and subsequent disposal or placement of materials removed.

B. Unauthorized Excavation: Inadvertent or purposely removing materials beyond indicated subgrade elevations or dimensions without specific direction of the Architect. Unauthorized

excavation, as well as remedial work resulting from unauthorized excavation directed by Architect shall be at Contractor's expense.

1. Unauthorized excavation, including disposition of additional excavated materials and other work resulting from slides, cave-ins or remedial work shall be at Contractor's expense.

C. Additional Excavation: When excavation has reached required subgrade elevation, the Architect will be notified and will make an observation of conditions. If Architect determines that bearing materials at required subgrade elevations are unsuitable, excavation shall be continued until suitable bearing materials are encountered and excavated materials shall be replaced as directed by the Architect.

1. Removal of unsuitable material and its replacement as directed will be paid on basis of Conditions of the Contract relative to changes in work.

D. Subgrade: The undisturbed earth or the compacted soil layer immediately below proposed playing field drainage or soil materials. This work is being performed by the Owner.

E. Finish subgrade: Final elevations and grading modifications to be performed in this Contract on the subgrade elevations. Playing field system to be installed above finish subgrade and topsoil to be added to finish subgrade in landscape areas. This work is being performed by the Contractor.

F. Gravel Drainage material: Stone material that may be used in drainage trenches surrounding perforated drainage piping. When used below and with the dynamic stone base, this material should bridge with the dynamic stone base as described herein.

G. Dynamic Stone Base: Approved stone material with the sizing and performance characteristics described herein. This stone material is installed immediately on top of the finished subgrade surface. This material could also be used in the drainage trenches if approved by the Engineer or Testing Agency.

H. Topping Stone: Approved stone material with the sizing and performance characteristics described herein. This stone material is installed immediately on top of the dynamic stone base to create a smooth surface for the placement of the synthetic turf as well as to aid in achieving finish grade tolerances of the playing field subsurface.

1.5 SUBMITTALS

A. Manufacturer's Product Data: Submit manufacturer's specifications and installation instructions for all products in the playing field system, including certifications and other data as may be required to show compliance with the Contract Documents.

B. Material Certifications: Manufacturer's or vendor's certified analysis for rubber and sand infill amendments.

C. Synthetic Turf Material Samples and Test Reports:

1. Synthetic Turf – 12" x 12" square sample for each system specified, in each color scheduled on the drawings, including field lines, letters, and logos.

2. Rubber/Sand Mix with proper ratio or Rubber - three samples, approximately 8-ounces each.

3. Submit to Owner for approval - quality assurance information as delineated in paragraphs 1.6 Quality Assurance below.

4. Certified list of successful existing installations, including Owner representative and telephone number, attesting compliance with quality assurance information.

5. Certified copies of independent (third-party) laboratory reports on ASTM tests as follows:
   a. Pile Height, Face Weight & Total Fabric Weight - ASTM D418.
   b. Primary & Secondary Backing Weights – ASTM D418.
   c. Tuft Bind – ASTM D1335.
   d. Grab Tear Strength – ASTM D1682.
   e. Dynamic Cushion Test (G-max) - ASTM F-355, Procedure A (system).

6. Seam – Sewn or glued per manufacturers' recommendation.
   a. 24 Inches in length.

7. Color: Submit sample of line markings for approval by Owner.

D. Supplier List: Submit list of procured and contracted suppliers for all materials required for the Playing Field System.

E. Schedule: Work schedule for all work described in these documents. This schedule shall be regularly updated and submitted as progress continues throughout ultimate completion.

F. Shop Drawings :
1. Sample Warranty.
2. Seam layout of the field. including location of all turf carpet seams and individual sections of turf (rolls), including approximate width and length.
3. Striping and field marking plan: Submit one for each field. Include dimensions line widths, and colors for each sport scheduled and details with dimensions for all letters, numbers, logos, and other field ornamentation.
4. Construction detail sketches, especially those that may deviate from the plans and specifications. Include but not limited to the following; perimeter turf anchor details, detail at irrigation valves, valve boxes, other inserts or fixed features, etc.

G. Manufacturer's Report: submit written statement, signed by Contractor and synthetic field surfacing installer stating that the Drawings and Specifications have been reviewed by qualified representatives of the materials manufacturer, and that they are in agreement that the materials and systems to be used for synthetic field surfacing are proper and adequate for the applications shown

H. Warranty: Provide a copy of the Turf Vendor's standard Warranty noting any exceptions to the Warranty information included in this Specification Section.

I. Turf Product System Hold Harmless: The Turf Vendor shall submit a document holding the Owner and it's representatives harmless as to any liability and or costs of any type, including but not limited to legal costs, royalties, replacement costs, etc. associated with any claim by the Turf Vendor or others associated and with any patents or infringements of any current or future patent issued for the synthetic turf product, infill materials, installation methods or drainage characteristics. It is not the intent of these documents to promote or induce the use of intellectual property belonging to others or promote infringement of any known or currently not known patents, licenses or rights of others.

J. Statement of Supervision: Upon completion of the Work, Contractor to submit a written statement signed by the synthetic turf manufacturer stating that the field supervision by the manufacturer's representative was sufficient to insure proper application of the complete system and materials, that the Work was installed in accordance with the Contract Documents, and that the installation

is acceptable to the manufacturer.

1.6 QUALITY ASSURANCE

A. The sports field contractor shall have previously installed at least six (6) artificial turf infill fields larger than 65,000 square feet in the last three (3) years.

1. The sports field contractor is responsible for the subgrade fine grading, installation of fabric, installation of field drainage system, installation of the perimeter nailing system, installation of field boxes, installation of the goal sets, and installation of the dynamic stone base.

B. The synthetic field turf installation shall be performed by a firm and crew having completed at least six (6) fields in the last three (3) years on projects of similar size and type to this project. The firm shall have the approval of the synthetic field surfacing materials manufacturer. The synthetic field installation superintendent shall provide a list of the five (5) projects for which he was responsible.

C. The Sports Field Contractor and the Synthetic Turf Manufacturer/Supplier must have been in business under the same ownership for at least three years, and shall have been installing similar sports fields for that entire period.

D. Provide workmen qualified and skilled in the specific type of synthetic turf installation.

E. Provide supervisory personnel certified by and directly employed by, the Turf Company.
1. Provide same supervisory personnel for entire duration of project unless replacement is required or approved by Owner.

F. Provide representative on site to verify installation and warranty requirements, including subgrade, drainage, and subbase installation.

G. Provide test results from certified laboratory certifying capability of aggregate base course (dynamic stone) to meet permeability and stability requirements before construction.

H. Lay test strip and establish compaction and density rates for each course with nuclear gauge before beginning permanent work.

1.7 QUALITY CONTROL

A. After Bid Award and Prior to construction: Submit samples of each of the following materials to establish Baseline specification and ratios for the remainder of the testing process.

1. Infill Materials: Provide a one gallon sample of each infill material to be used for testing. This shall include but is not limited to:
   a. Ambient, Cryo-ambient, crambient, cryogenic rubber or SBR rubber.
   b. Sand or gravels.

B. During Construction: Submit samples of each of the following during mass production of gravel materials for performance testing and prior to shipping.

1. Infill Materials:
   a. Random samples shall be pulled from bulk packages or piles on-site. Number of samples at the Owners discretion. The samples shall be tagged and marked from the packages for future reference after testing is complete. Sieve analysis testing results shall be compared to Vendor's previously submitted

analysis for the infill materials for approval. Packages that do not meet approval shall be removed from site. Initial testing shall be paid for by the Owner. Retesting shall be at the Contractors expense. Additional screening of rubber materials by Contractor to remove fines may be required at Own sole discretion at no additional cost to Owner.

2. Synthetic Turf Material Testing: Prior to shipment to the project site, one 12" 12' sample from a random roll shall be taken and tested by an independent laborato with experience testing these materials. The Engineer should be made aware of the pro tion process so that this random roll can be requested and selected for testin Test shall be submitted simultaneously to the Owner, Engineer and Co ctor. mples/Rolls not meeting approval shall not be shipped. Testing shall be paid for by the Co ractor. Samples used for testing shall be tagged and marked and sub to the Engineer after testing is complete. The following shall be tested/reporte

a. ASTM D418 - Pile Height, Face Weight & To Fabric eight
b. ASTM D418 - Primary & Secondary Ba ing We ts
c. ASTM D418 - Backing and Perforati Dia er an Spacing.
d. ASTM D1335 - Tuft Bind.
e. ASTM D1682 - Grab Tear Stre th.

3. Synthetic Turf Product Safety Sta

a. The Contractor shall omit sig d statement with documents from the turf manufacturer that prov nform ion on the safety of their product regarding lead, heavy me and other chemicals used in their product.

C. Testing Agents:

1. The Owner sha ontr and pay for, an independent testing agent to certify and make recommend s regarding compaction, concrete, geotechnical and other items required Wor The Playing Field Contractor shall notify the Owner regarding timing chedulin and use of these agents.

2. Playing ield Te ng Agent:

a. The Owner shall hire an independent Testing Agent to perform testing of the field system material components, as well as to certify the capability of the dynamic stone base course to meet permeability and stability requirements before construction.

1.8 DELIVERY, STORAGE AND HANDLING

A. All materials shall be delivered and stored within the Contractor's work limits or in an area approved by the Owner. Materials shall be inspected for damage immediately upon delivery.

B. All material shall be stored in strict accordance with the manufacturer's recommendations.

C. Special care shall be exercised during delivery and storage to avoid damage to the products.

D. Products that are damaged will be removed and replaced, unless the product can be repaired in an acceptable manner by the Contractor, at his expense.

E. Packaged Materials:

1. Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site.

1.9 COMPLETION AND ACCEPTANCE

A. General: Field completion shall be separated into 2 phases, “Preliminary Completion” and “Substantial Completion.”

B. Preliminary Completion: Scheduled date for preliminary completion shall be at least ten (10) calendar days before Substantial Completion. Notify the Playing Field Designer/Engineer and Owner in writing, three (3) days prior to scheduled date for observation for “Preliminary Completion.” To be considered “Preliminarily Complete” the following items shall be provided:

1. Drainage system installed.
2. Dynamic stone base in place, compacted and to grade.
3. Field curbing installed.
4. Synthetic turf installed inclusive of infill materials, field markings and logos.
5. Goal post sleeves installed.
6. Fencing installed (Refer to 323113 Chain Link Fences and Gates).
7. Irrigation system tested, installed and adjusted (Refer to 328400 Sports Field Irrigation).

C. Substantial Completion: After “Preliminary Completion” observation, the Playing Field Designer/Engineer and Owner shall prepare and submit to the Contractor, a punch list of items to be completed to achieve “Substantial Completion”. Contractor shall notify the Playing Field Designer/Engineer and Owner in writing, five (5) days prior to a requested date for a site observation to meet “Substantial Completion”. To be considered “Substantially Complete” or “Playable” the following items shall be provided:

1. All “Preliminary Completion” punch list items are complete.
2. Submit five (5) copies of written operating and maintenance instructions. Provide format and contents as directed by the Engineer.
3. Submit five (5) copies of certified surveys performed during construction for Quality Control.
4. Instruct the Owner or Owner’s personnel in the operation of the irrigation and other systems.
5. Smooth level playing surface level to grading tolerances.
6. Written warranties / guarantees.
7. Stockpiling / storage of required “attic stock” materials.
8. Upon completion of the synthetic field surface, the contractor shall provide the owner with two (2) hours of maintenance training that shall be recorded on a video tape and supplied to the Owner.
9. Upon completion, Contractor shall provide Owner with project as-built/record drawings.

1.10 WARRANTY/GUARANTEE

General: Warranties / Guarantees specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and are in addition to and run concurrent with other warranties/guarantees made by the Contractor under requirements of the Contract Documents.

B. The following are inclusive of the term “Playing Field System” for provisions of the guarantee:

1. Final grade tolerances to one-quarter inch in the length of 25' of finish grade in any direction.
2. Synthetic turf product as specified and represented by the Turf manufacturer/vendor.
3. All materials and products specified.
4. Drainage through the turf, infill and dynamic stone base shall be guaranteed to have a percolation rate of 6 inches per hour.

C. Playing Field System Installer Guarantee: The President/Principal(s) of both the Playing Field System installer and the Synthetic Turf Vendor (if different) shall sign this document and it shall include the following:

1. The turf product and its infill materials (defined as the turf system) shall be free from defects of material and workmanship for a period of ten (10) years from date of Substantial Completion/Acceptance of the Owner.
2. Any defects will be remedied on written notice at no additional cost to the Owner.
3. The ten (10) year warranty shall not be prorated.
4. The synthetic turf materials shall not fade, (significant loss of color), fail, wrinkle or show excessive wear.
5. The exposed turf surface shall not decrease more than 10% according to ASTM D418, nor exceed 50% during the warranty period. Portions of the field that fail to meet these standards shall be replaced in both materials and labor by the Contractor.
6. Turf product shall be adaptable to painted lines.
7. Seams shall not separate, become unglued or detached.
8. The entire turf system shall be resistant to weather, insect, rot, mildew and fungus growth and be non-allergenic and non-toxic.
9. The entire turf system shall be maximum dimensional stability, resist damage and normal wear from its designated use.
10. Adhesives used shall be resistant to moisture, bacteria, fungus and resist ultraviolet rays.
11. Guarantee shall include removal and replacement of materials (parts and labor) not performing to the standards described to repair synthetic field surfacing at no cost to the Owner.
12. At no time in the life of the Guarantee shall the G-Max exceed 175G's at any one point on the field.

D. Statement of Supervision: Upon completion of the Work, Contractor to submit a written statement signed by the synthetic turf manufacturer stating that the field supervision by the manufacturer's representative was sufficient to insure proper application of the complete system and materials, that the Work was installed in accordance with the Contract Documents, and that the installation is acceptable to the manufacturer.

E. G-Max Testing: The synthetic surface manufacturer shall retain a third party certified testing laboratory and shall perform G-Max testing during the first year of the life of the Guarantee.

1. Testing shall be performed at within 10' of mid center, at the goal locations for soccer and lacrosse, and at 10 yards inside the corners of football, soccer, and lacrosse. . This results in a total of 17 tests. The testing shall be performed between 90 and 120 days after substantial completion. (These tests are paid for by the Contractor).
2. Testing shall consist of shock attenuation per ASTM F-355-A (full system). Testing shall be in accordance with ASTM Test Method F-1936 or as described in these documents.
    a. Initial test shall not exceed 135G's nor shall it be less than 90G's at any one point on the field.
    b. G-Max shall not change more than 5% (five percent) at any one location per year over the life of the Guarantee.
        1) In cases where the results of the above testing exceed the specified values, the condition shall be corrected by the synthetic surface manufacturer. The synthetic surface manufacturer shall provide adequate information to confirm that the mitigation measures were effective.

c. At no time in the life of the Guarantee shall the G-Max exceed 175G's at any one point on the field. Results of this testing shall be provided to the Owner, Engineer and other assigns each year after testing.

3. The depth of the infill material shall be measured at the point of each test location.

4. The testing shall be performed by a certified independent lab and paid for by the Contractor.

5. If the Contractor does not perform the tests within 30 days of the dates noted, the Owner shall at its discretion order this work performed and the Contractor shall pay for this cost.

6. Future testing shall be performed by a certified independent lab and paid for by the Owner.

F. Contractor shall not be held liable for incidental or consequential damages. The Synthetic Turf Warranties described shall be conditioned upon:

1. Owner shall make all minor repairs to the synthetic turf system as discovered.

2. Owner shall maintain field as described in the Owner's Manual submitted by the Contractor to the Owner.

G. The Warranty does not cover any defect, failure, damage caused by or connected with abuse, neglect, deliberate acts, acts of God, casualty or uses exceeding the Contractor's recommendations.

1.11 SPARE PARTS/ATTIC STOCK

A. Stockpile Materials: Provide two (2) tons of Rubber Infill material, stored as directed by the Owner.

B. Turf: Material may be used of rolls or cutoffs. Minimum size of turf shall be 10' x 10'. Provide the following minimum materials and store as directed by the Owner.

1. Green Turf Field: 100 square feet.

a. If more than one color lot is used, each color lot shall be represented proportionately in the total.

2. Turf for Lines:

a. 50 Linear feet of 4 inch width for the colors white.

PART 2 - PRODUCTS

2.1 EARTHWORK MATERIALS

A. Earthwork materials shall meet the requirements of Specification "Earthwork" and "Synthetic Turf Subsurface Drainage System".

2.2 PERIMETER TURF ANCHOR/NAILER

A. The perimeter turf anchor/nailer shall be located at the field perimeter or turf edges and shall be as per drawings, or approved equal.

2.3 SYNTHETIC INFILL TURF PRODUCT

A. Fiber/Products:

1. Characteristics:

a. Finish pile height: 2.25" Nominal
b. Yarn Denier 10,000 Min.

c. Permeability 40" per hour
d. G-Max at install 100-135 Maximum.
e. G-Max over life of field 175 Max.

2. Approved Products, in no particular order:

a. Shaw "Spike Zone Pro" - A UV stable, monofilament polyethylene fiber and slit film fiber system with PE Spike Zone thatch layer

b. Astroturf "RootZone 3D3 Blend" 52 - A UV stable, monofilament polyethylene fiber and slit film fiber system with PE RootZone thatch layer.

c. Field Turf "Vertex Pro" 52 - A UV stable, monofilament polyethylene fiber and slit film fiber system with PE thatch layer.

d. SprinTurf "UltraBlade DFE-TT Extreme" 52 - A UV stable monofilament polyethylene fiber and slit film fiber system with PE thatch layer.

3. All inlaid lines will be tufted in the factory to the extent practical. The use of field inlaid lines will be kept to a minimum.

B. Appearance/Feel:
1. The finished playing surface shall appear as manicured grass with no irregularities and shall afford excellent traction for conventional athletic shoes of all types.
2. The finished surface shall resist abrasion and cutting from normal use.

C. Infill Materials
1. Each Manufacturer shall utilize their premium rubber and silicon sand system.
2. Rubber shall be dust, lead & metal free. Particle sizes shall be consistent in size and shape, between 2 and 3 mm.
3. Sand shall meet the following gradation:

Sieve Size	% Retained
2 mm	0
.5 mm	20-30
.3 mm	40-50
.15 mm	30-40
.05 mm	5-10

4. Infill material shall be as recommended by the turf system MFR. The sand component shall be as recommended by the turf system MFR.
5. The exposed fiber height shall be 3/8" ± 5/8" after 40 hours of field use or 90 days after placement.

Glued seams

1. Adhesives for bonding tufted synthetic turf shall be as recommended by the synthetic turf manufacturer. Adhesives shall be one-part moisture cured polyurethane.

E. Sewn Seams

1. Cord for sewing seam turf shall be as recommended by the synthetic turf manufacturer.

2.4 SYNTHETIC INFILL TURF MAINTENANCE EQUIPMENT

A. Provide (one) turf sweeping unit including all necessary tools and equipment to properly maintain the synthetic turf system including the alternate systems:

1. Supply a 6' wide field sweeper with magnet, which shall include a towing mechanism

compatible with a field utility vehicle. The field sweeper shall be the LitterKat 760 sweeper, or equal.

2. Supply one turf groomer. Turf groomer shall be 6' wide and be the Sportsturf Groom 920SDE by Greens Groom, or equal.

PART 3 - EXECUTION

3.1 EXAMINATION AND PROTECTION

A. Verification of Conditions: Examine areas and conditions under which all work of this Section is being performed. Do not proceed with any work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.

B. Protection of Work: Protect all on-going work, so as not to delay work due to weather or project related construction. This includes but is not limited to the use of tarps, geotextile, plywood and other protective measures.

C. Protection of Persons and Property: Provide all necessary measures to protect workmen and passersby. Barricade open excavations occurring as part of the work, as required by municipal or other authorities having jurisdiction.

1. Protect adjacent construction throughout the entire operation. Protect newly graded areas from destruction by weather or runoff. Protect structures, utilities, pavements, and other improvements from damage caused by settlement, lateral movement, undermining and washout.

D. Unanticipated Conditions: Notify the Engineer immediately upon finding evidence of previous structures, filled material that penetrate below designated excavation levels, or other conditions which are not shown or which cannot be reasonably assumed from existing surveys and geotechnical reports. Secure the Engineer's instruction before proceeding with further work in such areas.

E. Installation of synthetic field surfacing shall be done only after excavation and construction work which might injure it has been completed. Damage caused during construction shall be repaired before acceptance.

F. The Contractor shall coordinate the installation of the synthetic field surface and the surrounding surfaces for optimum interface at all edges.

3.2 TURF PERIMETER NAILER/ANCHOR

A. Install approved anchoring system at entire perimeter/edges of turf installation.

B. Install anchoring/nailing "collar" around other in place or installed items (quick coupler boxes, power/communication boxes, etc.), as appropriate to installation sequencing.

3.3 INSTALLATION OF SYNTHETIC TURF

A. Prior to beginning turf installation on any field, the Turf Installer shall submit a written statement accepting the playing field area conditions as described earlier in this Specification.

B. Synthetic turf shall be installed by crews approved by the Synthetic Turf manufacturer and employed by the General Contractor, (if different) in strict accordance with manufacturer's recommendations and instructions including but not limited to fabric, adhesives, seaming and

abutting or attaching to adjacent materials.

C. Field Markings and layout:

1. Field shall be temporarily secured at the edges with ballast or other similar means as reasonably possible to prevent wind from misaligning or moving the turf installation prior to and throughout the installation of the infill materials.
2. The field lines shall be tufted or inlaid for field sports as shown on the drawings.
3. All lines and markings shall be tufted in or installed as inlays. Wherever possible, lines shall be tufted into turf panels in lieu of inlays. All markings shall have distinct edges and shall not very more than 1/4 inch in width and location.
4. No head or cross seams shall be allowed within the line markings of the field area.
5. Any painted lines shall be by Owner.
6. Final field markings and lining of synthetic field surfacing shall be laid out as shown on the drawings, shop drawings and as approved by the Engineer and Owner.
7. Owner to make final determination of colors, markings, etc.

D. Seams and inlays:

1. All sewn seams (if used) shall be sewn with high strength polyester or nylon cord using a double loop stitch or glued with an adhesive as recommended by the synthetic turf manufacturer and installed per manufacturer's instructions.
2. All seams shall be flat, tight and permanent with no separation or fraying.
3. The width between fiber rows at seams shall be equal to that of the tufting gauge of the turf product.
4. All seams shall be brushed and fibers trimmed as necessary so as to appear "seamless".
5. All sewn seams shall be "butt seamed" to eliminate overlap so as to appear seamless.
6. All glued seams shall be brushed to eliminate adhesive materials from turf fibers.
7. Supplemental backing used at glued seams:
   a. Inlays shall bridge the seam or edges a minimum of 4 inches.
8. All inlaid lines shall be backed using seaming tape with a width of 12 inches or shaved in and glued to backing as per Turf Vendors premium installation methods.

E. Application of adhesive materials or infill materials shall not be applied when:

1. Air or material temperatures are below 10 degrees C.
2. Rain is falling or conditions exist or are pending that will be unsuitable to the installation.

F. Infill materials:

1. Do not begin installation of the infill materials until the field has been observed in the presence of the Engineer/Owner. Debris from turf installation shall be removed, seams and inlays shall be observed. Inlays using glue shall be properly set up before infill is added.
2. Apply dry materials when the turf is dry.
3. The path from the stored on-site infill materials shall be kept clean and clear to eliminate contamination onto the playing field area.
4. For installations utilizing 100% rubber infill, the infill shall be applied in numerous uniform layers over the entire surface with industry standard broadcasting equipment.
5. For installations utilizing sand and rubber infill, the infill shall be applied in numerous uniform layers over the entire surface with industry standard broadcasting equipment.

6. The Contractor shall utilize a combination of rolling and watering the surface after infill materials have been installed to settle the materials into the turf. After this process, the Engineer/Owner shall inspect the surface for footing and stability and possible settlement or unevenness of infill depth. Additional treatments may be required to achieve approval by the Owner and Engineer to achieve footing, stability and uniformity of infill depth.
7. Infill materials shall be applied at a uniform depth and at an ultimate finish grade tolerance of 1/4 inch at any point over the entire playing field area. Fill to a depth such that minimum of 3/8 inch of fiber is visible.
8. Fiber shall not be buried or trapped below infill material when complete.

G. Anchor turf edges at field perimeter attaching to concrete or pressure treated wood nailers. Glue and nails shall be used for entire installed perimeter to attach turf to the edge.

H. The finish turf surface shall have a permeability test performed on location on the field.

I. The permeability test shall utilize a dual ring infiltrometer in accordance with ASTM test method. All test results must be greater than 6 inches per hour.

3.4 FIELD MARKINGS

A. The field lines shall be tufted or inlaid per Owner designated sports. The final field markings shall meet the NFHS standards as shown on the striping plan drawings.
1. General:
a. Owner to make final determination of colors.
b. Refer to Drawings for layout of sports and line color associated with each sport.

3.5 CLEAN UP

A. At the end of each day, remove all scraps and other debris created by the synthetic turf installation from the playing field area.

B. At end of turf installation for each field and just prior to punch list, contractor to use magnetic device/equipment to remove all metallic materials on field caused by construction.

C. Remove all surplus excavated material not required for filling and backfilling, trash, and debris and dispose of it properly off of the Owner's property at Contractor's expense.

D. Leave premises and work in clean, satisfactory condition.

3.6 PROTECTION

A. Protection of materials and work shall be the responsibility of the Contractor during installation and thru acceptance/substantial completion. All material damaged prior to acceptance shall be replaced at no cost to the Owner.

END OF SECTION 321813

SECTION 321823.26 – NATURAL FIELD SPORT SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes preparation of ground surfaces, fertilizing, seeding, and maintenance of turf areas as shown on the drawings or as specified herein.

B. Seeding shall occur within the specified planting periods unless otherwise approved by the Landscape Architect.

1.3 SUBMITTALS

A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

B. Qualification Data: For qualified landscape Installer.

C. Product Certificates: For soil amendments and fertilizers, from manufacturer.

D. Material Test Reports: For existing planting soil and imported topsoil.

E. Subcontractor List: Submit a list of proposed subcontractors for the project. Briefly describe the role of each as well as their experience with similar types of facilities such as being constructed in these documents. This list should include but is not limited to:
   1. Seed Installer
   2. Seed Supplier and Contact

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified Installer whose work has resulted in successful turf establishment.
   1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
   2. Experience: Three years' experience in turf installation in addition to requirements in Division 01 Section "Quality Requirements."
   3. Installer's Field Supervision: Require installer to maintain an experienced full-time supervisor on project site when work is in progress.
   4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
      a. Certified Landscape Technician - Exterior, with specialty area(s), designated CLT-Exterior.
      b. Certified Turfgrass Professional, designated CTP.
      c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.

5. Maintenance Proximity: Not more than two hours normal travel time from maintenance professional's place of business to project site.
6. Pesticide Applicator: State licensed, commercial.

B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.
1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Landscape Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
3. Report suitability of tested soil for turf growth.
   a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
   b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, molybdenum, vanadium, and zinc. If such problem materials are present, provide additional recommendations for corrective action.

D. Pre-installation Conference: To Be Arranged

1.5 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

B. Bulk Materials:
1. Do not stockpile or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

1.6 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance.
1. Spring Seeding: March 15 – June 15
2. Fall Seeding: August 15 – November 15
3. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit seeding to be performed when beneficial and optimum results may be obtained. Apply

products during favorable weather conditions according to manufacturer's written instructions. No work shall be performed when the ground is frozen, wet or otherwise un-tillable or when even distribution of materials cannot be obtained.

1.7 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape installer. Maintain as required in Part 3. Begin maintenance immediately after each area is seeded and continue until acceptable turf is established but for not less than the following periods:
   1. Seeded Turf: 90 days from date of installation.
      a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

B. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future optional

PART 2 - PRODUCTS

2.1 MATERIALS

A. Seed:
   1. 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.
   2. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
      30 percent Perennial Ryegrass 'Homerun' (turf type) (Lolium perenne, 'Homerun').
      30 percent Tall Fescue, 'Raptor II (turf type) (Festuca arundinacea (Lolium arundinaceum, 'Raptor II').
      15 percent Kentucky Bluegrass 'Shamrock' (Poa pratensis, 'Shamrock')
      15 percent Kentucky Bluegrass, 'Volt' (Poa pratensis, 'Volt')
      10 percent Annual Ryegrass (Lolium multiflorum (L. perenne var. italicum))

   3. Grass Seed Mix: Proprietary seed mix as follows:
      a. Products: Subject to compliance with requirements, As specified by Ernst Conservation Seeds "Athletic Field Mix #106" or approved equivalent.

B. Fertilizer:
   1. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.
   2. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
   3. 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.
   4. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
      a. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
      b. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
      c. For lawns, provide fertilizer with not less than 4% phosphoric acid and not less than 2% potassium and the percentage of nitrogen required to provide not less than 1 lb. of actual nitrogen

per 1000 sq. ft. of lawn area. Provide nitrogen in a form that will be available to the lawn during the initial period of growth.

C. Water: Clean, potable.

D. Top Soil:
1. **Topsoil shall be from off-site sources.** It shall be without admixture of subsoil or slag and shall be free of stones, lumps, plants or their roots, sticks and extraneous matter, and shall not be moved, placed or used while in a frozen or muddy condition.
2. Topsoil from off-site sources shall have an acidity range of pH 5.0 to 7.0 and shall contain not less than 5% organic matter as determined by the "Walkley-Black Method" (Colorimetric version). Sufficient limestone shall be added to topsoil used to bring it to a range of pH 6.0 to pH 6.5.
3. Soil sample tests will be ordered by the Contractor and supplied to the Landscape Architect and shall be made by a state or commercial laboratory using methods approved by the Association of Official Agricultural chemists or the State Agricultural Experiment Station.
4. Such analysis will be paid for by the Contractor. Moving and placing of topsoil may be made after approval of the analysis by the Landscape Architect.
5. Topsoil shall meet the following mechanical analysis:

	Passing %	Retained %
1" Screen	100%	
1/2" Screen	97-100%	0-3%
No. 100 Mesh Sieve	60-40%	40-60%

6. There shall be a minimum of 6” of topsoil spread for seed installation on field areas as called for on the drawings.

2.2 ACCESSORIES

A. Soil Amendments:
1. Soil amendments are not to be made without review and authorization by the Landscape Architect.
2. Lime: Natural limestone containing not less than 85% of total carbonates, ground so that not less than 90% passes a 10-mesh sieve and not less than 50% passes a 100-mesh sieve.
3. Herbicide: Apply a pre-emergent herbicide to the installed topsoil. Apply a post-emergent herbicide when weed infestation exceeds 5% of any planted grass area. Reapply post-emergent herbicide application until weeds are eradicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
   1. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of [illegible] water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum 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.
   1. Thoroughly blend planting soil off-site before spreading.
      a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
      b. Mix lime with dry soil before mixing fertilizer.
   2. Spread soil mix to a depth of 6 inches but not less than required to finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
      a. Spread approximately 1/2 the thickness of soil mix over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of soil.

C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
   1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
   2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
   3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
   4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

D. Playing Field Subgrade:
   1. All cutting, filling, backfilling and grading necessary shall be done to bring the playing field areas to the following subgrade tolerances:
   2. The final elevation of the finish playing field subgrade shall be plus or minus one half inch at any point in the field and on a 25 foot by 25 foot grid of the finished grades indicated on the Contract Drawings. Laser controlled or indicated equipment shall be used for this part of the work.
      a. Playing Field Subgrade Elevation Certification: A certified survey by a State licensed land surveyor shall be performed at 25-foot centers to verify grade and elevation of the subgrade. The digital survey document shall indicate spot elevations and tenth of foot contours and shall be submitted to the Engineer for review and approval prior to moving to next part of work
   3. General:
      a. After verification and approval of the subgrade, the Playing Field Contractor shall then proceed with the fine grading of the subgrade. All fine grade cutting, filling, and backfilling necessary to be performed on the subgrade to bring the playing field areas finish subgrade to the required tolerances.

b. Finish subgrade shall mirror the final finish elevation of the field surface in regards to slope except where noted on the drawings.
c. Compaction for the finish subgrade shall meet 95% Standard Proctor as described in quality control section of this specification.
d. Proofrolling of the finish subgrade is required in the presence of the geotechnical engineer.
e. Sufficient grading must be done during the progress of the work so that the entire site shall be well drained and free from water pockets.

4. Quality Control
   a. Subgrade Ground Surface Requirements:
      1. Perform density tests in accordance with ASTM A1556, ASTM D6767, or ASTM D2022
      2. Perform moisture tests in accordance with ASTM D3017.
      3. Where field-testing is performed using nuclear test methods, verify calibration of both density and moisture gages at the beginning of work on each different type of material encountered, and additionally as directed by the Engineer
   b. Fill and Backfill Materials: Test existing on-site soils and low plasticity fills proposed for use in filling and backfilling operations as follows. Allow testing services to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.

Moisture Content:	ASTM D2216
Maximum Index Density:	ASTM D4253
Moisture Density Relation:	ASTM D698
Plasticity Index:	ASTM D4318

   c. Subgrade Material: One test for every 2500 square foot of compacted subgrade material, or major fraction thereof, but in no case less than two tests for each day's work

5. Playing Field Finish Subgrade Tolerance Requirements: The final elevation of the finish subgrade shall be plus or minus one half inch from the field and on a 25 foot by 25 foot grid grade as indicated on the Contract Drawings.
6. Playing Field Finish Subgrade Elevation Certification: A certified survey by a State licensed land surveyor shall be performed at 25 foot centers to verify required grade and elevation tolerances of the finish subgrade. The digital survey document shall indicate spot elevations and tenth of foot contours and shall be submitted to the Engineer for review and approval prior to moving to next part of work.
7. Finish Grading: Grade Playing Field area to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

E. Moisture prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Before seeding, obtain Landscape Architect's acceptance of finish grading; restore playing field areas if eroded or otherwise disturbed after finish grading.

3.4 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
   1. Do not use wet seed or seed that is moldy or otherwise damaged.
   2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 75-150 lbs per acre, or 3-5 lbs per 1,000 s.f.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with erosion-control mats where shown on Drawings; install and anchor according to manufacturer's written instructions.

E. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
   1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
   2. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

F. Protect seeded areas from hot, dry weather or drying winds by applying peat mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/1 inch, and roll surface smooth.

3.5 ESTABLISHMENT AND MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
   1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
   2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
   3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
   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 turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate to maintain adequate moisture in the upper 4 inches of soil.

   3. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowing. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowing to maintain the height between 1-1/2 and 2-1/2 inches of seeded areas.

C. Turf Post fertilization: Apply fertilizer after initial mowing and when grass is dry.
   1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.6 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Landscape Architect:
   a. Satisfactory Seeded Turf: 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 and bare spots not exceeding 5 by 5 inches.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.7 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with owner's operations and others in proximity to the work. Notify owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.8 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION

SECTION 321823 – SYNTHETIC RUNNING TRACK SURFACING (Base Bid & Alternates)

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 the following:

1. All weather resilient synthetic track surface over asphalt base with striping.

B. Related Sections include the following:

1. Division 32 Section "Asphalt Paving" for constructing asphalt concrete paving base platform for running track upon which resilient running track surface is to be placed.

1.3 SCOPE

A. The synthetic surfacing contractor shall furnish all labor, materials, equipment, supervision and services necessary for the proper completion of the synthetic track surfacing system and related work indicated on the drawings and specified herein.

B. The synthetic surfacing contractor shall refer to the drawings for the required locations of synthetic track surfacing to be installed. All quantities and dimensions shall be field verified by the synthetic surfacing contractor.

1.4 SPECIFIC SCOPE OF WORK

A. Install an IAAF, NFHS approved, synthetic track system: a 13mm polyurethane bound impermeable running track surface with structural spray finish.

Layout and paint all lines and event markings as required and specified by current NFHS, IAAF, and NCAA rules. The contractor shall consult with the owner prior to the start of their calculations for determination of the finish line location, events to be run, location of lane numbers and additional paint markings. All requested markings shall be provided.

1.5 COORDINATION

The synthetic surfacing contractor shall coordinate the work specified with an authorized and appointed representative of the owner so as to perform the work during a period and in a manner acceptable to the owner.

1.6 APPLICABLE PUBLICATIONS

Codes and standards follow the current guidelines set forth by the International Association of Athletics Federation (IAAF), the National Collegiate Athletic Association (NCAA) or the National Federation of State High School Associations (NFHS), along with the current material testing guidelines as published by the American Society of Testing and Materials (ASTM).

1.7 SUBMITTALS

A. Request for deviations or substitutions from the specifications must be made in writing seven days prior to the bid date. Complete product data including specifications, application rates, mixing instructions and a sample shall be sent with the request to the District and/or Engineer for an evaluation. Alternatives will be allowed only by addendum.

B. Product Data: Three (3) sets of manufacturer's product data sheets including installation guidelines and maintenance instructions.

C. Samples for Verification: Three (3) representative track samples in the color of surfacing to be installed.

D. Product Certificates: Signed by manufacturers of track surfacing certifying that products furnished comply with requirements and are suitable for the use indicated.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

F. Test results from an IAAF Testing Laboratory confirming compliance to the performance of athletic tracks test according to the IAAF.

1.8 PERFORMANCE STANDARDS

A. The synthetic track surfacing system shall exhibit the following minimum performance standards as required by IAAF:

	Thickness	≥ 13mm
2.	Force Reduction	35 to 50%
3.	Modified Vertical Deformation	0.6 to 1.8mm
4.	Friction	≥ 47 TRRL Skid Resistance
	Tensile Strength	≥ 0.5 MPa
	Elongation at Break	≥ 40%

1.9 QUALITY ASSURANCE

A. General Contractor / Bidder Qualifications:

1. The bidder shall be engaged in the construction of All Weather Synthetic (IAAF Certifiable) Running Tracks as a primary business enterprise and shall demonstrate the construction of five (5)

complete running track projects within the last 5 years. It will be required that the bidder/contractor has performed at minimum 75% of the work with his/her own forces. The 5 projects must be submitted on company letterhead and turned in at the time of the bid. Financial statements for the previous five (5) years will be made available upon request. The bidder shall also be required to have a full time employee on staff with a "Certified Track Builder (CTB)" designation as awarded by the American Sports Builder's Association (ASBA). A current CTB certificate shall be included with the bid package for this project. Asphalt paving contractor and all weather surfacing contractor must be listed on the list of subcontractor form with [illegible]

B. Asphalt Paving Contractor Qualifications:

1. The contractor/sub-contractor, shall to the satisfaction of the design professional for this project, demonstrate a proven capability, specifically, in the construction of asphalt pavements for running track surfaces and have been in business, under the present name a minimum of five (5) years from the date of this bid. Upon request, financial statements for the previous five (5) years will be made available upon request.

2. All asphalt leveling and asphalt layers are to meet the tolerances of the American Sports Builders Association (ASBA) guidelines and the National Federation of State High School Association (NFSHSA) requirements. It shall be the contractor's responsibility to demonstrate his/her ability to achieve all requirements concerning cross slope, longitudinal slope, planarity and compaction as outlined in these association's manuals.

3. The contractor/sub-contractor shall construct all hot mix asphalt layers utilizing an asphalt paver that is equipped with a laser controlled screed system and automatic slope control. The laser level that is used to control this work shall be recently calibrated and certified as to the accuracy of the instrument.

4. The contractor/sub-contractor shall demonstrate that he has, satisfactorily, completed at least <u>three</u> (3) running tracks in the past five years, utilizing the laser and slope controls. A list of these running tracks shall be furnished with the bid package. The contractor/sub-contractor shall be required to furnish an as-built report, from an independent Professional Engineer or Licensed Surveyor certifying that the installed asphalt meets or exceeds the related guidelines and requirements for asphalt pavements relating to running tracks.

C. Track Surfacing Contractor Qualifications:

1. The contractor/sub-contractor, shall to the satisfaction of the design professional for this project, demonstrate a proven capability, specifically, in the installation of All Weather Systems of the scope and type proposed for this project and demonstrate that they have been in business, under the present name, a minimum of five (5) years from the date of this bid. The contractor/sub-contractor shall demonstrate that he has, satisfactorily, completed at least <u>five</u> (5) running tracks in the past five years. Upon request, financial statements for the five previous years shall be required. An experienced factory trained installer who has specialized in installing similar in material, design, and extent to those indicated for this project and whose work has resulted with a record of successful in-service performance.

2. The surfacing contractor/sub-contractor shall utilize equipment that is considered "state of the art" including an automatic computerized mixer. The system installed shall be an IAAF Certified System.

3. Upon request and for evaluation of previous installations, the surfacing contractor/sub-contractor shall furnish the name, owner and contact person for every track surface that they have installed in

the five previous years.

D. The uniformity of both grade and planarity is intended to meet governing body specifications. Slop shall meet those set forth in the rules for track and field for the intended use of the facility (NFSHS . Complete rules and regulations are available from the National Federation of State High Sch Associations (NFSHSA) at 816-464-5400. Slopes shall not be less than .75%.

E. The finished surface of the leveling course shall not vary more than 1/8" in any direction measu with a 12' straight-edge. Elevations shall be taken every twenty-five feet in the running ction inside edge, centerline and outside edge of track. Elevations on the pole vault, long jump and igh jump shall be taken on a 10' grid. Any area that does not have the correct cross slope shall be cume d and reported to the owner prior to construction start up and staging of materials. Minimum curing time for base prior to beginning of surfacing is 14 days for new asphalt paving.

F. Track surfacing contractor shall check the asphalt for compliance, and reject for correction, any base which is not within specifications.

G. Certification – Upon completion of the finish course of asphalt base construction shall be checked by a licensed professional engineer or land surveyor for compliance with the lines and grades set forth in the plans and specifications. Upon completion of the survey, a licensed professional engineer or land surveyor shall certify that the track and field events were constructed in accordance with the plans and specifications. Costs associated with preparation of certification shall be incidental to the asphalt paving contract.

H. Line striping and event markings shall be laid out in accordance with current IAAF and NCAA rules. Upon Completion of the installation, the owner shall be supplied with all necessary computations and drawings as well as a letter of certification attesting to the accuracy of the markings. All line marking paint is to be approved be the synthetic surfacing manufacturer. Only an experienced track-striping specialist shall perform line striping.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation.

B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration and damage due to moisture, high or low temperatures, contaminants, or other causes.

1.11 PROJECT CONDITIONS

A. Asphalt Substrate: The asphalt upon which the TRACK SURFACE is installed shall be clean, free-draining and shall exhibit the planarity and tolerances set forth in Court and Field Diagram Guide as published by the National Federation of State High School Associations (NFSHSA).

B. Weather Conditions: The quality of the installation is dependent upon proper weather conditions. No installation shall be made when rain is imminent or when ambient temperatures are below 50 degrees F. It is best to install the system in sunny weather with day-time temperatures of at least 60 degrees F. When night-time temperatures fall below 45 degrees F, the system should not be installed.

C. Installation shall not take place if adjacent or concurrent construction generates excessive dust, abrasives or any other by-product that, in the opinion of the installer, would be harmful to the track material, until completion of such works.

1.12 WARRANTY

A. All synthetic track surfaces shall be fully warranted against defects in workmanship and materials. The specific length of the warranty shall be five (5) years. The contractor shall repair or replace defective surface at no cost to the owner. Excluded from the warranty are defects caused by faulty design, acts of God, improper maintenance, abuse, and uses other than those set forth above. The owner is required to maintain the facility in accordance with the maintenance instructions which are provided with the warranty.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Primers

1. Shall be a polyurethane based primer formulated to be compatible with SBR. . Qualipur, or approved equal.

B. Rubber (Black SBR)

1. Base mat rubber shall be specifically Styrene Butadiene Rubber (SBR). Rubber granules shall be recycled SBR rubber 1 to 3mm in size, containing less than 1% dust. Shall be dried to no less than 2.5% moisture and sealed in bags.

C. Polyurethane Binder

1. The basemat shall be bound by a moisture-cured polyurethane binding agent, compatible with basemat rubber. Qualipur, or approved equal. Basemat shall be installed with a specially designed track-paving machine to an average depth of 11mm. No machine sprayed basemat systems will be accepted.

D. EPDM Powder Rubber

1. The basemat shall be sealed off using powdered rubber mixed with a two component full pour polyurethane. Qualipur, or approved equal.

E. Seal Layer

The seal layer shall be made from a two component full pour polyurethane with no solvents or fillers added. Qualipur 5050 (A & B), or approved equal.

Structural Spray Coating

Shall be a solvent based single-component, polyurethane, specifically formulated for compatibility with EPDM granules. The coating shall be Red. Pigment intergraded in the field shall not be allowed.

G. Line Marking Paint

1. Single-component, moisture cured, aliphatic polyurethane paint compatible with the synthetic track surfacing.

2.2 REPRESENTATIVE PRODUCT

A. Basis of Design – Spurtan Synthetic Track Surfacing System as manufactured by:

1. Advanced Polymer Technology
109 Conica Lane PO Box 160
Harmony, PA 16037
(724) 452-1330
System: Spurtan BSS

B. Accepted Alternative Products:
1. Beynon Sport Surfaces, Inc.
16 Alt Road
Cockeysville, MD 21030
(410) 771-9473
System: BSS 200

*Subcontractors of alternative products listed above must verify that the manufacturer's product listed is an equal alternative to the basis of design.

PART 3 - EXECUTION

3.1 EXAMINATION

A. After the existing track surface has been completely removed and cleaned, the contactor shall inspect existing asphalt base for structural integrity, planarity and slope, and overall condition. Check planarity and slope using 4m level. Examine existing track surface for compliance with requirements for joint configuration, installation tolerances and other conditions affecting track surface performance.

B. Geotechnical testing of the asphalt base shall be performed. A geotechnical engineer shall prepare a recommendation report. The report should identify the condition of the existing base and recommend if milling of the existing base and installing 1-1/2" finish course is required. Recommended compaction of existing asphalt should be at 75%-8[illegible]% (ASTM 6931). Should the existing asphalt not meet recommended compaction and/or the base exhibits excessive cracking and subsurface failure, the owner and construction manager shall be notified immediately. Based on the site examination and geotechnical engineer's recommendation, the owner shall have the opportunity to select the asphalt surface milling & overlay alternate (approximately 1-1/2").

C. Proceed with installation only after unsatisfactory conditions have been corrected and work scope has been approved by the owner, engineer and installer.

3.2 INSTALLATION

A. Finish Course of Asphalt

1. The Synthetic Track Surfacing System shall be laid on an approved sub-base. The General Contractor shall provide compaction test results of 95% or greater for the installed asphalt surface.

2. For NCAA certification the following criteria must be followed. The track surface, i.e. asphalt substrate, shall not vary from planned cross slope by more than + .2%, with a maximum lateral slope outside to inside of 1%, and a maximum slope of 0.1% in any running direction. The

finished asphalt shall not vary under a 12' straight edge more than 1/8".

3. It should be the responsibility of the asphalt-paving contractor to flood the surface immediately after the asphalt is capable of handling traffic, but within 24 hours. If, after 20 minutes of drying time, there are birdbaths evident, it shall be the responsibility of the architect, in conjunction with the surfacing contractor to determine the method of correction. No cold tar patching, skin patching or sand mix patching will be acceptable.

4. Any oil spills (hydraulic, diesel, motor oil, etc.) must be completely removed either by chipping out or removing and replacing with new, keyed in asphalt. The curing time for new asphalt base is 28 days. It shall be the responsibility of the surfacing contractor to determine if the asphalt substrate has cured sufficiently prior to the application of polyurethane surface system.

5. It shall be the responsibility of the track surface contractor to determine if the asphalt substrate meets all design specifications, i.e. cross slopes, planarity and specific project criteria. After all the above conditions are met, the synthetic surfacing contractor must, in writing, accept the planarity of the asphalt receiving base, before work can commence.

B. Thickness

The thickness of the Synthetic Track Surfacing System shall be _____mm.

C. Equipment

The Synthetic Track Surfacing System components shall be processed and installed by specially designed machinery and equipment. A mechanically operated paver with variable regulated speed and thermostatically controlled screed shall be used in the installation of the base mat. The wearing course shall be installed using automatic electronic proportioning, which provides continuous mixing and feeding for an accurate, quality controlled installation.

D. Installation

1. The entire surface shall be clean and free of dirt, oil grease or any other foreign matter upon arrival of the installation team. Any dirt, etc. shall be pressure washed off the base by the general contractor.

2. Prime the entire asphalt surface area with a compatible polyurethane primer. Mask and protect adjacent structures, as required. Primer shall dry to a tack-free condition, but no longer than 24 hours, before application of the base mat. This shall be applied at a rate of approximately 0.29 pounds per square yard.

3. The base mat is to be blended in a fully automatic continuous mixer for binder and rubber granules. The material usage rate shall be approximately 3.5 pounds per square yard of polyurethane binder and 15 pounds per square yard of SBR rubber. The installation of the base mat is to take place using a paving machine that is specifically designed for this type of application (SMG 936, or equal).

4. Mix the two-component resin and EPDM powder into a thixotropic mixture and applied to the basemat by means of spreading the material with a rubber squeegee to seal off the mat. The material usage rate shall be approximately 2.2 pounds per square yard of two component resin and 1.0 pound per square yard of EPDM powder.

5. Top Layer: After the seal layer has cured or is tack-free but no longer than 24 hours, the structural

spray should be mixed with EPDM spray rubber until thoroughly coated. The mixture should be sprayed in two separate applications. Apply the second coat, in an opposite direction as to the first.

The mixture should be sprayed in two layers at a minimum application rate of 1.90 lbs/yd² for structural spray and 1.27 lbs/yd² EPDM spray rubber. Apply specified amounts to achieve proper coverage.

3.3 POST-INSTALLATION INSPECTION

A. Mat Construction: The track and field event surface shall be constructed in accordance with methods approved by the manufacturer of the system.

B. The finished surface shall be uniform in appearance, depth and density.

C. Provide track markings in accordance with NFSHSA, IAAF, and NCAA rules and regulations.

3.4 CERTIFICATION

Upon completion of the installation, the owner shall be supplied with all necessary computations and drawings as well as a letter of certification attesting to the accuracy of the markings.

3.5 CLEANING

Clean off excess material as the Work progresses by methods and with cleaning materials approved by product manufacturers.

3.5 PROTECTION

Protect track surface during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so track surfaces 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 track surface immediately so installations with repaired areas are indistinguishable from the original work.

3.5 GUARANTEE

The Synthetic Track Surfacing System shall be fully guaranteed against faulty workmanship and material failure for a period of five (5) years from the date of acceptance.

Synthetic surfacing material found to be defective as a result of faulty workmanship and/or material failure shall be replaced or repaired at no charge, upon written notification within the guarantee period.

END OF SECTION 321823

SECTION 321823 – RECREATIONAL COURT SURFACING

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 the following:

1. All weather resilient acrylic-bound basketball and tennis courts ("athletic courts" hereon) over asphalt base, with striping.
2. All tennis court crack repair systems.

B. Related Sections include the following:
1. Division 321216 "Asphalt Paving" for constructing asphalt concrete paving base platform for athletic courts upon which surface mix is to be placed.

1.3 SUBMITTALS

A. Product Data: For material indicated, along with test data from an independent testing lab. Test results for weatherometer test, flexibility test and water resistance test.

B. Samples for Verification: For each type and color of material required.

C. Product Certificates: Signed by manufacturers of tennis surface certifying that products furnished comply with requirements and are suitable for the use indicated.

D. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.4 QUALITY ASSURANCE

General Contractor / Bidder Qualifications:

1. The bidder shall be engaged in the construction of Tennis and/or Basketball Court Construction as a primary business enterprise and shall demonstrate the construction of six (6) complete tennis or basketball court projects within the last 3 years. Financial statements for the previous three (3) years will be made available upon request. Asphalt paving contractor and colorcoating surfacing

contractor must be listed on the list of subcontractor form with the bid proposal.

B. Asphalt Paving Contractor Qualifications:

1. The contractor/sub-contractor, shall to the satisfaction of the design professional for this project, demonstrate a proven capability, specifically, in the construction of asphalt pavements for athletic court surfaces and have been in business, under the present name a minimum of five (5) years from the date of this bid. Upon request, financial statements for the previous five (5) years shall be made available upon request.

2. All asphalt leveling and asphalt layers are to meet the tolerances of the American Sports Builders Association (ASBA) guidelines and the National Federation of State High School Association (NFSHSA) requirements. It shall be the contractor's responsibility to demonstrate his/her ability to achieve all requirements concerning cross slope, longitudinal slope, planarity and compaction as outlined in these association's manuals.

3. The contractor/sub-contractor shall construct all hot mix asphalt layers utilizing an asphalt paver that is equipped with a laser controlled screed board and automatic slope control. The laser level that is used to control this work shall be recently calibrated and certified as to the accuracy of the instrument.

4. The contractor/sub-contractor shall demonstrate that he has, satisfactorily, completed at least <u>six</u> (6) tennis or basketball court projects in the past three years, utilizing the laser and slope controls, including certifications for this work. Upon request, the contractor/sub-contractor shall be required to furnish a report, from an independent Professional Engineer or Licensed Surveyor certifying that the installed asphalt meets or exceeds the related guidelines and requirements for asphalt pavements relating to athletic courts.

C. Colorcoating Surfacing Contractor Qualifications:

1. The contractor/sub-contractor, shall to the satisfaction of the design professional for this project, demonstrate a proven capability, specifically, in the installation of Colorcoat Systems of the scope and type proposed for this project and demonstrate that they have been in business, under the present name, a minimum of five (5) years from the date of this bid. Upon request, financial statements for the five previous years shall be required.

2. Upon request and for evaluation of previous installations, the surfacing contractor/sub-contractor shall furnish the name, owner and contact person for every athletic court surface that they have installed in the three previous years.

D. Acceptance Test: Prior to application of a color finish system, the court surface shall be flooded with water and allowed to drain for one hour at 70 degrees. There shall be no ponding or bird bath areas on the tennis or basketball courts deeper than a U.S. nickel laid flat. Any ponding or bird bath areas not meeting this requirement shall be patched and leveled by the Contractor. Reflood and patch until "birdbaths" are eliminated.

E. Quality Assurance: Comply with Delaware Department of Transportation Standard Specifications, latest edition.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation.

B. Store and handle materials to comply with manufacturer's written instructions to prevent the deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 PROJECT CONDITIONS

A. Weather Limitations: Do not apply prime and tack coats when temperature is below 50 deg F (10 deg C) or when base is wet. Apply hot-mixed asphalt paving only when temperature is above 40 deg F (4 deg C) and when base is dry

B. Drainage: The areas adjacent to the tennis courts shall be graded to prevent surface water away from the stone and asphalt base. Subsurface drainage shall provide for a free flow of subsurface moisture away from the stone base.

C. WARRANTY

D. The TENNIS COURTS shall be warranted against defects in workmanship and materials and structural cracking. The specific length of the warranty shall be five (5) years. The contractor shall repair or replace defective surface at no cost to the owner. Excluded from the warranty are defects caused by faulty design, acts of God, improper maintenance, abuse and uses other than those set forth above. The owner is required to maintain the facility in accordance with the maintenance instructions which are provided with the warranty. Warranty shall be in the form of a Performance Bond.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Athletic Court Surfacing Materials shall be Novacrylic® Novaplay® Basketball/Multi-Sport Coating, as manufactured by Nova Sports U.S.A., 6 Industrial Rd., Bldg. #2., Milford, MA 01757. 800-USA-NOVA or approved equal. All coatings shall be pure acrylic, containing no asphaltic or tar emulsions, nor any vinyl, alkyd or non-acrylic resins. The color system shall be factory-mixed compounds requiring only the addition of water at the jobsite except for the addition of sand to Novasurface® . All materials shall be delivered to the jobsite in sealed containers with the manufacturer’s label affixed.

Surfacing material shall be provided in the manufacturer’s colors of Red and Gray. Contractor shall submit color mock-ups of court color scheme and layout.

2. Line paint shall be factory-compound product compatible with asphalt. White line paint shall be Novatex or approved equal Latexite Acrylic Line Paint. Use undiluted for painting of playing lines.

3. Basketball goals shall be furnished by other trades and installed by the contractor.

4. Surface Course: Type D, meeting the requirements of DOT Specifications, Section 401.

5. Leveling Course: Type C, meeting the requirements of DOT Specifications, Section 401.

6. Graded Aggregate Base Course: DOT Specifications Section 302 and Section 821, (Type 3 crusher run).

7. Concrete: "Class B" (3,000 psi) meeting the requirements of DOT Specifications, Section 602.

B. Stonedust: DOT Specifications, Section 307 and Section 813, (gradation requirements for No. 10).

C. Herbicide Treatment: Commercial chemical for weed control, registered by Environmental Protection Agency and approved by the State of Maryland. Provide granular, liquid, or wettable powder form.

D. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
   a. Allied Chemical Corp.
   b. Achem Products, Inc.
   c. Ciba-Geigy Corp.
   d. Dow Chemical U.S.A.
   e. E.I. Dupont De Nemours & Co., Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine base course with Installer present for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting tennis court surface performance.

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

3.2 CONSTRUCTION PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Proof roll the subgrade and do all necessary rolling and compaction to obtain a firm, even subgrade surface conforming to the lines and grades set forth on the plans and consolidate depressed areas. Remove all unsuitable materials, replace with clean fill, and compact to 100% of the maximum dry density in accordance with ASTM D-1557 Modified Proctor Method.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of .05 to .15 gal/sq. yd. (0.2 to 0.7 L/sq. m).
   Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   Avoid smearing or staining adjoining surfaces, appurtenances, and surrounding. Removed spillages and clean affected surfaces.

3.3 INSTALLATION: STONE BASE

A. Herbicide Treatment: Apply chemical weed control agent in strict compliance with manufacturer's recommended dosages and application instructions. Apply to compacted, dry subbase prior to application of prime coat.

B. Filter Fabric: Install filter fabric over area to receive base.

C. Spreading: The stone base material shall be spread by methods, and in a manner proposed by the contractor to produce a uniform density and thickness and the grades and dimensions shown on the drawings.

D. Compaction: The stone base shall be compacted by rolling with a powered steel wheel tandem roller weighing not less than eight tons. The compacted surface of the stone base shall not vary more than ½" from the required elevations.

E. Furnish and install stone dust to fill all cracks and construct minimum one inch (1") compacted thickness layer over the stone base surface. The stone dust shall be dampened and placed in all surface cracks and compacted with a vibrator plate compactor so that the compacted stone dust is level with the adjacent tennis court surface. The Contractor shall continue to place and dampen the stone dust to achieve maximum compaction with a three to five ton (3-5 ton) roller(s) placing thin layers of stone dust, until there is a minimum of one inch (1") thick compacted layer of stone dust. The average inplace density shall be at least 95% of the lab density when tested in accordance with the appropriate AASHTO requirements. The finished surface of the stone dust base course shall not vary more than one-quarter inch (1/4") in ten feet (10') when measure in any direction. Coordinate the installation of ground sleeves.

3.4 INSTALLATION: LEVELING COURSE

A. Paving joints in the Leveling Course and Surface Course shall be constructed so as to prohibit joints being placed directly upon one another. The contractor may cross-cross paving operations of the Leveling and Surface Courses (but the surface asphalt course must be layed perpendicular to the net line) on the Stone Dust Sub-Base, or by varying the width of the paving passes, if courts are to be paved in the same directions. Compaction shall be performed in accordance with the requirements contained elsewhere in the Contract Documents.

B. Construct a Bituminous Stabilized Leveling Course Mix Type C, two and one half inches (2-1/2") Compacted Thickness, over the Stone Dust Sub-Base followed by the construction of a Bituminous Concrete Surface course Mix Type D.

C. Spreading: The asphalt mixture shall be spread using a mechanical asphalt spreader, the condition of which shall be suitable for achieving the tolerances specified hereinafter. The minimum compacted thickness shall be 2½ as indicated on the drawings.

D. Compaction: The asphalt mixture shall be thoroughly compacted with a steel wheel tandem roller weighing not less than four tons. The finished surface of the leveling course shall not vary more than ¼" from the required elevations.

3.5 INSTALLATION: SURFACE COURSE

A. Following the construction of the Bitumious Concrete Surface Course Mix Type D, check the entire newly constructed surface for depressions over one-eighth inch (1/8"). The Contractor shall check the finished surface with a ten foot (10') straight edge; projections and/or depressions of more than one-eighth inch (1/8") in ten feet (10') shall be corrected before proceeding. The contractor shall asphalt patch any and all depressions one-half inch (1/2") and over.

B. Spreading: The asphalt mixture shall be spread using a mechanical asphalt spreader, the condition of which shall be suitable for achieving the tolerances specified hereinafter. The minimum compacted thickness shall be 1-½ " as indicated on the drawings.

C. Compaction: The asphalt mixture shall be thoroughly compacted with a steel wheel tandem roller weighing not less than four tons. The finished surface of the surface source shall not vary more than 1/8" from the required elevations, nor shall it vary more than 1/8" in any direction when measured with a ten foot straightedge.

D. Allow fourteen (14) days curing time for the Asphalt Surface Course before proceeding with the [illegible] and cleaning of loose material(s) from the entire surface area.

3.6 POST-INSTALLATION INSPECTION

A. Inspection of Competed Asphalt Paving: Upon completion, the asphalt pavement shall be inspected by a licensed professional engineer or land surveyor. The inspection shall verify that dimensions, slopes and elevations of the asphalt paving meet the tolerances set forth herein. Areas of the asphalt paving which do not meet the tolerances shall be corrected by the paving contractor. High spots shall be milled to the proper elevations, or may be cut out and replaced. Low areas shall be corrected by removing the 1.5" surface course of asphalt and replacing with hot surface course mix.

3.7 ACRYLIC FINISH INSTALLATION

A. New asphalt pavement shall cure for 14 days prior to application of any surfacing materials.

B. Contractors must notify the Landscape Architect of all applications, 48 hours prior to installation. The surface to be coated shall be inspected and made sure to be free of grease, oil, dust, dirt and other foreign matter before starting work.

C. The surface shall be flooded. Any ponding water remaining that is deep enough to cover the thickness of a five-cent piece shall be corrected using a patch mix consisting of Novabond® , 50-mesh sand and Portland cement, as per manufacturer's directions. Depressions must be primed with a 50% dilution of Novabond® and water prior to patching.

D. Application shall proceed only if the surface is dry and clean and the temperature is at least fifty degrees (50°F) and rising, and the surface temperature is not in excess of one hundred forty degrees (140°F). Do not apply coatings when rain is imminent.

E. Each coat in the system must dry completely before next application. Between each coat, inspect entire surface. Any defects should be repaired. Scrape surface to remove any lumps, and broom or blow off all loose matter.

F. Using a neoprene rubber squeegee, apply one (1) coat of Novasurface® acrylic resurfacer, diluted with one (1) part clean water to two (2) parts Novasurface®. Clean, bagged sand shall be incorporated into the diluted Novasurface® at the rate of five (5) to ten (10) Lbs. per gallon. Sand gradation shall be 50 to 60-mesh. Allow application to dry thoroughly.

G. Using a neoprene rubber squeegee, apply two (2) coats of Novafil® , diluted two (2) parts concentrated material to one (1) part clean water (colors to be designated by owner). Allow each application to dry thoroughly. The quantity of water used in diluting these coatings may exceed the quantity specified by only a small amount and only if coatings are drying too rapidly. Permission of the owner shall be obtained before adding additional water.

H. Using a neoprene rubber squeegee, apply one (1) coat of Novacoat®, diluted one (1) part concentrated material to one (1) part clean water (colors to be designated by owner). Allow application to dry

thoroughly. The quantity of water used in diluting these coatings may exceed the quantity specified by only a small amount and only if coatings are drying too rapidly. Permission of the owner shall be obtained before adding additional water.

3.8 ACRYLIC FINISH INSTALLATION LINE MARKINGS

A. Upon completion and acceptance of the athletic court surface, this Contractor shall prepare and paint lines for basketball.

B. All lines are to be applied by painting between masking tape with a paintbrush or roller according to U.S.T.A specifications.

C. Prime masked lines with Seal-A-Line®. Allow application to dry.

D. Paint lines with Novatex® textured line paint. Allow application to dry.

E. Remove masking tape immediately after lines are dry.

F. Protect adjacent areas and structures (fences, posts, sidewalks, building walls, etc.), which are not to be coated. In the event that coatings are applied to above, remove immediately before drying is complete.

3.9 COMPLETION

A. Upon completion, the contractor shall insure proper removal of all construction debris, surplus materials, empty containers and wash water, and shall leave the site in a condition acceptable to the owner. The court is to be left secure so as to prevent vandalism.

3.10 CLEANING

A. Clean off excess material as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur. Upon completion remove all containers, debris, etc. and leave the site in acceptable condition.3.9

3.11 PROTECTION

A. Protect tennis court surface during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so track surfaces 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 tennis court surface immediately so installations with repaired areas are indistinguishable from the original work.

END OF SECTION 321818

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SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Galvanized-steel chain link fabric.
2. Galvanized-steel framework.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 31 Section "Earth Moving" for filling and grading work.
2. Division 03 Section "Cast-in-Place Concrete" for concrete bases for post settings.

1.3 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data in the form of manufacturer's technical data, specifications, and installation instructions for fence and gate posts, fabric, gates, gate operators, and accessories.

C. Shop drawings showing location of fences, gates, each post, and details of post installation, extension arms, gate swing, hardware, and accessories.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has at least three years' experience and has completed at least five chain link fence projects with same material and of similar scope to that indicated for this Project with successful construction record of in-service performance.

B. Single-Source Responsibility: Obtain chain link fences and gates, including accessories, fittings, and fastenings, from a single source.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for fences and gates shown on the Drawings in relation to the property survey and existing structures. Verify dimensions by field measurements.

1.6 MISCELLANEOUS REQUIREMENTS

A. Deliver, store, uncrate, handle and install in manner to prevent damage to equipment.

B. Remove promptly from site all debris resulting from installation of materials and equipment specified herein.

C. Finish of all materials and equipment shall be appropriate for exterior locations.

PART 2 - PRODUCTS

2.1 GENERAL

A. Dimensions shown for pipe, roll-formed, and H-sections are outside dimensions.

B. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

1. Allied Tube and Conduit Corp.
2. Anchor Fence, Inc.
3. Wheatland Tube
4. Davis Walker Corp.
5. Dominion Fence and Wire Prod.
6. United States Steel

2.2 FABRIC - FENCING

A. Selvage: Knuckled at both selvages for heights 72 inches and below. Height above 72" shall be twisted (barbed) at one end and knuckled at the other.

B. Steel Chain-Link Fence Fabric: Fabricated in one-piece widths for fencing 8 feet and less in height to comply with Chain Link Fence Manufacturers Institute (CLFMI) Product Manual and with requirements indicated below:

1. Mesh and Wire Size:
   A. Standard Fence - 2-inch mesh, 0.148-inch diameter (9 gauge).
   B. Backstops – 2 –inch mesh, 0.192 diameter (6 gauge) lower panels, 2- inch mesh, 0.148 inch diameter (9 gauge) upper panels.
2. Coating: ASTM A 817, Type 2, Class 2, zinc-coated, hot dipped galvanized after weaving (GAW).

C. All baseball/softball , backstops, auxiliary, stadium, football stadium and tennis fencing shall be PVC coated as follows:

1. Coating: ASTM F 668, Class 2b, PVC.
2. PVC Coating Color: Black

2.3 FRAMING

A. Round member sizes are given in actual outside diameter (OD) to the nearest thousandth of inches. Round fence posts and rails are often referred to in ASTM standard specifications by nominal pipe sizes (NPS) or the equivalent trade sizes in inches. The following indicates these equivalents all measured in inches:

Actual OD	NPS Size	Trade Size
1.315	1	1-3/8
1.660	1-1/4	1-5/8
1.900	1-1/2	2
2.375	2	2-1/2
2.875	2-1/2	3
3.500	3	3-1/2
4.000	3-1/2	4
6.625	6	6-5/8
8.625	8	8-5/8

B. Type I Round Posts: Standard weight (schedule 40) galvanized-steel pipe conforming to ASTM F 1083, according to heavy industrial requirements of ASTM F 669, Group IA, with minimum yield strength of 25,000 psi, not less than 1.8 oz. of zinc per sq. ft. Type A coating inside and outside according to

ASTM F 1234, as determined by ASTM A 90, and weights per foot as follows:

Actual OD	Weight (lb/ft)	NPS Size
1.315	1.68	1
1.660	2.27	1-1/4
1.900	2.72	1-1/2
2.375	3.65	2
2.875	5.79	2-1/2
3.500	7.58	3
4.000	9.11	3-1/2
6.625	8.97	6
8.625	28.55	8

C. Top Rail: Manufacturer's longest lengths (17 to 21 feet) with swedged-end or expansion-type coupling, approximately 6 inches long for joining. Provide rail ends or other means for attaching top rail securely to each gate corner, pull, and end post.

1. Round Steel: 1.660-inch OD Type I or II steel pipe.

D. Framing

1. Steel posts for fabric heights under 6 feet:

a. Round Line or Intermediate Posts: 1.900-inch OD Type I or II steel pipe.
b. Round End, Corner, and Pull Posts: 2.375-inch OD Type I or II steel pipe.
c. Top Rail: Manufacturer's longest lengths, with expansion type couplings, approximately 6" long, for each joint. Provide means for attaching top rail securely to each gate, corner, pull and end post.
   1) 1.66O OD pipe, 2.27 lbs. per ft.

d. All baseball/softball, auxiliary stadium and football stadium fence frames, posts and fittings shall be PVC coated according to the following:
   1) Coating: ASTM F 668, Class 2A, PVC.
   2) PVC Coating Color: Black.

2. Steel posts for fabric heights 6 feet:

a. Round Line or Intermediate Posts: 2.375-inch OD Type I or II steel pipe.
b. Round End, Corner, and Pull Posts: 2.875-inch OD Type I or II steel pipe.
c. Top Rail: Manufacturer's longest lengths, with expansion type couplings, approximately 6" long, for each joint. Provide means for attaching top rail securely to each gate, corner, pull and end post.
   1) 1.66O OD pipe, 2.27 lbs. per ft.

d. All baseball/softball including backstops, auxiliary stadium and football stadium fence frames, posts and fittings shall be PVC coated according to the following:
   1) Coating ASTM F 668, Class 2A, PVC.
   2) PVC Coating Color: Black.

3. Steel posts for fabric heights of 8 feet:

a. Round Line or Intermediate Posts: 2.875-inch OD Type I or II steel pipe.
b. Round End, Corner, and Pull Posts: 3.500-inch OD Type I or II steel pipe.
c. Top & Center rail: Manufacturer's longest lengths, with expansion type couplings, approximately 6" long, for each joint. Provide means for attaching top rail securely to each gate,

corner, pull and end post.
1) 1.66O OD pipe, 2.27 lbs. per ft.

d. All baseball/softball including backstops, auxiliary stadium and football stadium fence frames, posts and fittings shall be PVC coated according to the following:
1) Coating ASTM F 668, Class 2A, PVC.
2) PVC Coating Color: Black.

4. Backstops:

a. Round Line or Intermediate Posts: 4.000-inch OD Type I or II steel pipe.
b. Round End, Corner, and Pull Posts: 4.000-inch OD Type I or II steel pipe.
c. Top Rail, center rail & bottom rail: Manufacturer's longest lengths, with expansion type couplings, approximately 6” long, for each joint. Provide means for attaching top rail securely to each gate, corner, pull and end post.
1) 1.66O OD pipe, 2.27 lbs. per ft.

d. All baseball/softball fence and backstop frames, posts and fittings shall be PVC coated according to the following:
1) Coating: ASTM F 668, Class 2A, PVC.
2) PVC Coating Color: Black.

5. Tennis courts:

a. Round Line or Intermediate Posts: 4.000-inch OD High strength, HS 83K, Type I or II steel pipe.
b. Round End, Corner, and Pull Posts: 4.000-inch OD High strength, HS 83K, Type I or II steel pipe.
c. Top Rail, center rail & bottom rail: Manufacturer's longest lengths, with expansion type couplings, approximately 6” long, for each joint. Provide means for attaching top rail securely to each gate, corner, pull and end post.
1) 1.66O OD pipe, 2.27 lbs. per ft.

d. All tennis court frames and fittings shall be PVC coated according to the following:
1) Coating: ASTM F 668, Class 2A, PVC.
2) PVC Coating Color: Black.

2.4 FITTINGS AND ACCESSORIES

A. Material: Comply with ASTM F 626. Mill-finished aluminum or galvanized iron or steel to suit manufacturer's standards.

1. Steel and Iron: Unless specified otherwise, hot-dip galvanize pressed steel or cast-iron fence fittings and accessories with at least 1.2 oz. zinc per sq. ft. as determined by ASTM A 90.
2. Supplemental Color Coating: In addition to above metallic coatings, where specified, provide a 10-mil minimum polyvinyl chloride (PVC) plastic resin finish applied to exterior surfaces and, except inside cap shapes, to exposed interior surfaces. Color to match chain link fabric.

Post and Line Caps: Provide weathertight closure cap for each post. Provide line post caps with loop to receive tension wire or top rail.

C. Bottom and Center Rail: If shown on detail, same material as top rail. Provide manufacturer's standard galvanized-steel, cast-iron or cast-aluminum cap for each end. Provide bottom rail at baseball/softball backstop only. Provide center rail at 8N high fences or over.

D. Tension or Stretcher Bars: Hot-dip galvanized steel with a minimum length 2 inches less than the full height of fabric, a minimum cross section of 3/16 inch by 3/4 inch, and a minimum of 1.2 oz. of zinc

coating per sq. ft. Provide one bar for each gate and end post, and two for each corner and pull post, except where fabric is integrally woven into the post.

E. Tension and Brace Bands: 3/4-inch-wide minimum hot-dip galvanized steel with a minimum of 1.2 oz. of zinc coating per sq. ft.

1. Tension Bands: 0.074 inch thick (14 gage) minimum.
2. Brace Bands: 0.105 inch thick (12 gage) minimum.

F. Tension Wire: 0.177-inch-diameter metallic-coated steel marcelled tension wire conforming to ASTM A 824 with finish to match fabric. Provide at all fencing except baseball/softball backstop.

1. Coating Type II zinc in the following class as determined by ASTM A 6

Class 2, with a minimum coating weight of 1.20 oz. per sq. ft. of coated wire surface.

G. Tie Wires: 0.106-inch-diameter (12-gage) galvanized steel with a minimum of 0.80 oz. per sq. ft. of zinc coating according to ASTM A 641, Class 3 or 0.148-inch-diameter (9 gage) aluminum wire alloy 1350-H19 or equal, to match fabric wire.

2.5 CONCRETE

A. Concrete: Provide truck poured concrete consisting of portland cement per ASTM C 150, aggregates per ASTM C 33, and potable water. Mix materials to obtain concrete with a minimum 28-day compressive strength of 2500 psi. Use at least four sacks of cement per cubic yard., 1-inch maximum size aggregate, 3-inch maximum slump.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install fencing to comply with ASTM F 567. Do not begin installation and erection before final grading is completed, unless otherwise permitted.
1. Apply fabric to outside of framework. Install perimeter fencing inside of property line established by survey as required by Division 1.

B. Excavation: Drill or hand-excavate (using post-hole digger) holes for posts to diameters and spacings indicated, in firm undisturbed or compacted soil.

If not indicated on Drawings, excavate holes for each post to minimum diameter recommended by fence manufacturer, but not less than four times the largest cross section of post.
2. Unless otherwise indicated, excavate hole depths approximately 3 inches lower than post bottom, with bottom of posts set not less than 36 inches below finish grade surface.

C. Setting Posts: Center and align posts in holes 3 inches above bottom of excavation. Space a maximum of 10 feet o.c., unless otherwise indicated.

1. Protect portion of posts above ground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.

a. Unless otherwise indicated, extend concrete footings 2 inches above grade and trowel to a crown to shed water.

D. Top Rails: Run rail continuously through line post caps, bending to radius for curved runs and at other

posts terminating into rail end attached to posts or post caps fabricated to receive rail. Provide expansion couplings as recommended by fencing manufacturer.

E. Center Rails: Install center rails in one piece between posts and flush with post on fabric side, using rail ends and special offset fittings where necessary.

F. Brace Assemblies: Install braces at end and gate posts and at both sides of corner and pull posts. Locate horizontal braces at midheight of fabric on fences with top rail and at two thirds fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Bottom Tension Wire: Install tension wire within 6 inches of bottom of fabric before stretching fabric and tie to each post with not less than same gage and type of wire. Pull wire taut, without sag. Fasten fabric to tension wire with 0.120-inch-diameter (11-gage) hog rings of same material as finish fabric wire, spaced a maximum of 24 inches o.c.

H. Fabric: Leave approximately 2 inches between finish grade and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Install fabric on security side of fence, and anchor to framework so that fabric remains under tension after pulling force is released.

I. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not over 15 inches o.c.

J. Tie Wires: Use wire of proper length to secure fabric firmly to posts and rails. Bend ends of wire to minimize hazard to persons or clothing.

1. Maximum Spacing: Tie fabric to line posts 12 inches o.c. and to rails and braces 24 inches o.c.

K. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts for added security.

END OF SECTION 323113

SECTION 323300 - SITE FURNISHINGS

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. Bicycle racks.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for setting pipe sleeves cast in concrete footings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for color and texture specified.

C. Samples for Initial Selection: For units with factory-applied finishes.

D. Samples for Verification: For each type of exposed finish, not less than 6-inch- (152-mm-) long linear components and 6-inch- (102-mm-) square sheet components.

E. Product Schedule: For site furnishings: Use same designations indicated on Drawings.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For site furnishings to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 BICYCLE RACKS (BR-1)

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

1. Basis-of-Design Product: The design is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product submitted for approval no less than 10 days prior to bid date.

B. Basis-of Design Product: Inverted U Bike Rack on Rails form Park Warehouse.

1. Frame: Galvanized steel.

a. Tubing OD: Not less than **1-5/8 inches (41 mm)**.

2. Style: Double-side parking.

a. Overall Height: 37-1/2".
b. Overall Width: 30".
c. Overall Length: 126".
d. Capacity: Designed to accommodate no fewer than [two] [three] [four] [insert number> bicycles.

3. Installation Method: Surface flange anchored at finished grade to substrate indicated.

C. Steel Finish: Color coated.

1. Color: Match Architect's samples.

2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated; free of surface blemishes and complying with the following:

1. Rolled or Cold-Finished Bars, Rods, and Wire: ASTM B211 (ASTM B211M).
2. Extruded Bars, Rods, Wire, Profiles, and Tubes: ASTM B221 (ASTM B221M).
3. Structural Pipe and Tube: ASTM B429/B429M.
4. Sheet and Plate: ASTM B209 (ASTM B209M).
5. Castings: ASTM B26/B26M.

B. Steel and Iron: Free of surface blemishes and complying with the following:

1. Plates, Shapes, and Bars: ASTM A36/A36M.
2. Steel Pipe: Standard-weight steel pipe complying with ASTM A53/A53M, or electric-resistance-welded pipe complying with ASTM A135/A135M.
3. Tubing: Cold-formed steel tubing complying with ASTM A500/A500M.
4. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A513/A513M, or steel tubing fabricated from steel complying with ASTM A1011/A1011M and complying with dimensional tolerances in ASTM A500/A500M; zinc coated internally and externally.
5. Sheet: Commercial steel sheet complying with ASTM A1011/A1011M.
6. Finish: Manufacturer's standard.

C. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M; recommended in writing by manufacturer, for exterior applications.

D. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound; resistant to erosion from water exposure without needing protection by a sealer or waterproof coating; recommended in writing by manufacturer, for exterior applications.

E. Galvanizing: Where indicated for steel and iron components, provide the following protective zinc coating applied to components after fabrication:

1. Zinc-Coated Tubing: External, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, polymer fi[illegible]. Internal, same as external or consisting of 81 percent zinc pigmented coating, not less than 0.3 [illegible] (0.0076 mm) thick.
2. Hot-Dip Galvanizing: According to ASTM A123/A123M, ASTM A153/A153M, or ASTM A924/A924M.

2.3 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consiste[illegible] curves, [illegible]nes, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

B. Welded Connections: Weld connections continuously. Weld s[illegible]aberi[illegible] full-length, full-penetration welds and hollow members with full-circumferenc[illegible] welds. A[illegible] exposed connections, finish surfaces smooth and blended, so no roughness or unevenness s[illegible]ys after [illegible]ishing and welded surface matches contours of adjoining surfaces.

C. Pipes and Tubes: Form simple and compound curv[illegible] bend[illegible] members in jigs to produce uniform curvature for each repetitive configuration req[illegible]ed; [illegible]ain [illegible]ylindrical cross section of member throughout entire bend without buckling, twisti[illegible] crac[illegible]ng, [illegible]otherwise deforming exposed surfaces of handrail and railing components.

D. Preservative-Treated Wood Compon[illegible] Complete f[illegible]brication of treated items before treatment if possible. If cut after treatment, appl[illegible]field [illegible]atment complying with AWPA M4 to cut surfaces.

E. Exposed Surfaces: Polished, sand[illegible] otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; al[illegible]s and [illegible]ds rolled, rounded, or capped.

F. Factory Assembly: Fa[illegible]ory assem[illegible] components to greatest extent possible to minimize field assembly. Clearly mark units for [illegible]embly in[illegible]e field.

2.4 GENERAL [illegible]ISH REQUIREMENTS

A. Ap[illegible]arance of F[illegible]hed Work: Noticeable variations in same piece are unacceptable. Variations in [illegible]pearance of adjoining components are acceptable if they are within the range of approved Samples and [illegible]ssembled or installed to minimize contrast.

[illegible]5 [illegible]ALUMINUM FINISHES

A. [illegible]owder-Coat Finish: Manufacturer's standard polyester powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.6 STEEL AND GALVANIZED-STEEL FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

B. PVC Finish: Manufacturer's standard, UV-light stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on, PVC-plastisol finish, with flame retardant added; complying with coating manufacturer's written instructions for pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

C. Install site furnishings level, plumb, true, and [**securely anchored**] [**positioned**] at locations indicated on Drawings.

D. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.

E. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch (19 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

F. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

END OF SECTION 323300

SECTION 329200 - TURF AND GRASSES

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. Execute the work of this Specification in accordance with applicable portions of;
   1. Division 1 – General Requirements
   2. Drawings L-101

1.2 SUMMARY

A. Section Includes:

   1. Seeding.
   2. Meadow grasses and wildflowers.

B. Related Sections:

   1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
   2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
   3. Division 32 Section "Landscape Architecture" for plantings.

1.3 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 EXTERNAL DOCUMENTS

A. The Delaware Erosion and Sediment Control Handbook; 2005 Update. Availab[le] at http://www.dnrec.delaware.gov.

1.5 ACTION SUBMITTALS

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

1. Pesticides and Herbicides: Include product label and manufacture[r] appli[cation] instructions specific to this Project.

1.6 INFORMATIONAL SUBMITTALS

A. Certification of Grass Seed: From seed vendor f[or] grass[] monostand or mixture stating the botanical and common name, percentage by weig[ht] of ea[ch] cies and variety, and percentage of purity, germination, and weed seed. Include the year of p[ro]du[ction] a[nd] date of packaging.

1. Certification of each seed mixture to be utiliz[ed] the project. Include identification of source and name and telephone numb[er] pplier.

B. Qualification Data: For qualifie[d] ndsc[ape] ller.

C. Product Certificates: For [so]ndi[ners] and fertilizers, from manufacturer.

D. Material Test Reports: [F]or existin[g] n-place surface soil and imported topsoil.

E. Maintenance I[n]structions: [Re]commended procedures to be established by Owner for maintenance of turf during a ca[len]dar ye[ar]. Submit before expiration of required initial maintenance periods.

1.7 QU[A]LITY ASSU[RA]NCE

A. In[s]ller Qualifications: A qualified landscape Installer whose work has resulted in successful turf estab[lish]ment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Three years' experience in turf installation in addition to requirements in Division 01 Section "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:

a. Certified Landscape Technician - Exterior, with specialty area(s), designated CLT-Exterior.
b. Certified Turfgrass Professional, designated CTP.
c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.

5. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
6. Pesticide Applicator: State licensed, commercial.

B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recogni[z]d by the State Department of Agriculture, with the experience and capability to conduct the test indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report [by] qualifi[d] soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and [cl]ay co[n]t; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient co[n]t of t[h] oil.

1. Testing methods and written recommendations shall comply with USDA [H]book[.] 60.
2. The soil-testing laboratory shall oversee soil sampling, with de[s]; locatio[n] and number of samples to be taken per instructions from Architect. A minimum [o]ree repr[e]ntative samples shall be taken from varied locations for each soil to be used or amende[d] [f]r pla[n]g purposes.
3. Report suitability of tested soil for turf growth.

   a. Based on the test results, state recommendations f[o]il treatm[e]nts and soil amendments to be incorporated. State recommendations in [w]ight p[e] 1000 sq. ft. or volume per cu. yd. for lime, nitrogen, phosphorus, and potash nu[t]nts a[n]il amendments to be added to produce satisfactory planting soil suita[b]r hea[l]viable plants.
   b. Report presence of problem salts, m[i]erals [o]heavy metals, including aluminum, arsenic, barium, cadmium, chromium, c[o]lt, l[e]d, m[o]ium, and vanadium. If such problem materials are present, provide additi[o]recom[m]endations for corrective action.

D. Pre-installation Conference: To Be Ar[r]nced

1.8 DELIVERY, STORAGE, AND H[A]DLING

A. Seed and Other Packa[g]d Ma[t]ls: [D]eliver packaged materials in original, unopened containers showing weight, certi[f]d analysis[,] name and address of manufacturer, and indication of conformance with state and federal l[a]s, as appl[i]able.

B. Sod: (NOT [U]SED).

C. Bulk Materials.

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge [o]soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

1.9 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance.

1. Spring Planting: March 15 – June 15
2. Fall Planting: September 15 – November 15

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.

1.10 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:

1. Seeded Turf: 90 days from date of installation.

a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

2. Sodded Turf: (NOT USED)

B. Initial Meadow Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than 90 days from date of installation.

C. Continuing Maintenance Proposal: From Installer to Owner in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.1 All materials shall comply with the Delaware Erosion and Sediment Control Handbook; 2005 Update. Available at http://www.dnrec.delaware.gov.

2.2 TEMPORARY STABILIZATION SEED

A. Grass Seed: Mix No. 5 (annual ryegrass) in accordance with detail de-esc-3.4.3, sheet 1 of 4 within the Delaware Erosion and Sediment Control Handbook.

B. Seed Species: Annual Ryegrass. Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
1. All areas: Annual Ryegrass (Lolium temulentum).
2. Apply at 125#/acre.
Planting depth, 0.5 inches.

2.3 PERMANENT GRASS SEED

A. Apply mix No. 7 in accordance with DE-ESC-3.4.3, sheet 2 of 4 within the Delaware Erosion and Sediment Control Handbook.
1. All areas: Mix No. 7
2. Apply at 150 #/acre.

2.4 BIOSWALE GRASS SEED

A. Apply mix No. 4 in accordance with DE-ESC-3.4.3, sheet 2 of 4 within the Delaware Erosion and Sediment Control Handbook.
1. All areas: Mix No. 4
2. Apply at:
a. Strong Creeping Red Fescue - 100 #/acre.
b. Kentucky Bluegrass (Blend) - 70 #/acre.
c. Perennial Ryegrass - 15 #/acre.
d. Redtop - 10 #/acre.

2.5 MEADOW GRASSES AND WILDFLOWERS

A. Eastern Ecotype Native Grass Mix: Fresh, clean, and dry new seed of mixed species as follows:

1. ERNMIX-177
a. All areas denoted as meadow
b. Apply at 15lb / acre:
1) 35.0% Andropogon gerardii, Albany Pine Bush, NY Ecotype
2) 30.0% Sorghastrum nutans, New England 2 Ecotype
3) 20.0% Panicum virgatum, [illegible]
4) 15.0% Elymus virginicus, PA [illegible] type

B. Seed Carrier: Inert material, shall be clean sand, mixed with seed at a ratio of not less than two parts seed carrier to one part seed.

2.6 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 85 percent calcium carbonate , ground so that at least 90% passes a 10 mesh sieve and not less than 30% passes a 100 mesh sieve. Apply at the rate adequate to bring pH range up to 6.0 to 6.5.

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.7 ORGANIC SOIL AMENDMENTS

A. Compost: 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 ½ inch sieve; soluble salt content of 4 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to planting; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.

C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

2.8 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. 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.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
3. For lawns, provide fertilizer with not less than 4% phosphoric acid and not less than 2% potassium and the percentage of nitrogen required to provide not less than 1 lb. of actual nitrogen per 1000 sq. ft. of lawn area. Provide nitrogen in a form that will be available to the lawn during the initial period of growth.

2.9 PLANTING SOILS

TOPSOIL

Topsoil shall be from off-site sources. It shall be without admixture of subsoil or slag and shall be free of stones, lumps, plants or their roots, sticks and extraneous matter, and shall not be moved, placed or used while in a frozen or muddy condition.

Topsoil from off-site sources shall have an acidity range of pH 5.0 to 7.0 and shall contain not less than 5% organic matter as determined by the "Walkley-Black Method" (Colorimetric version). Sufficient limestone shall be added to topsoil used to bring it to a range of pH 6.0 to pH 6.5.

Soil sample tests will be ordered by the Landscape Architect and shall be made by a state or commercial laboratory using methods approved by the Associates of Official Agricultural chemists or the State Agricultural Experiment Station.

Such analysis will be paid for by the Contractor. Moving and placing of topsoil may be made after approval of the analysis by the Landscape Architect.

If approved, natural topsoil not having the hydrogen-ion value specified above may be amended by the contractor, at his own expense, to bring it within the specified limits. Topsoil shall meet the following mechanical analysis:

	Passing %	Retained %
1" Screen	100%	0%
1/2" Screen	97-100%	0-3%
No. 100 Mesh Sieve	60-40%	40-60%

There shall be a minimum of 4" of topsoil (after settlement) in all planting beds, pit plantings, ground cover areas, and lawns or as called for on the drawings, whichever is greater.

B. LIGHT WEIGHT ON-STRUCTURE PLANTING SOIL (NOT USED)

2.10 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Hardwood Bark Mulch (Shredded)
1. Shredded Hardwood Bark Mulch made of various hardwoods, mostly Oak, is ground (hammer milled) through a screen to provide a shredded, fibrous material. This is coarse mulch with large pieces down to fines. The pH shall range between 6 and 7.

C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

D. 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 2-5 millisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content 50-60 percent of dry weight.
Feedstock: (NOT USED).

E. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

F. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

G. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.11 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.12 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.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-bonded fiber mesh, a minimum of 0.92 lb/sq. yd. with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples,

C. Erosion-Control Mats: Cellular, non-biodegradable sheet stabilization mats designed to isolate and contain small areas of soil over steeply sloped surfaces. Include manufacturer's recommended anchorage system for slope conditions.

2.13 GRASS-PAVING MATERIALS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
Uniformly moisten excessively dry soil that is not workable and which is too dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge soil bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum 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.

1. Thoroughly blend planting soil off-site before spreading.

a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
b. Mix lime with dry soil before mixing fertilizer.

2. Spread planting soil to a depth of 4 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

a. Spread approximately 3/4 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.
b. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Unchanged Subgrades: Where lawns to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Turf Area Preparation" Article.

B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

C. Fill cells of erosion-control mat with planting soil and compact before planting.

D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.
2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of as noted on plans.

C. Rake seed lightly into top 1/4 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.

E. Protect seeded areas with erosion-control mats where shown on Drawings; install and anchor according to manufacturer's written instructions.

F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded area. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
   Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

G. Protect seeded areas from hot, dry weather or drying winds by applying peat mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.6 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with [fiber-mulch manufacturer's recommended tackifier.
2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than [1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
3. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry over coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

3.7 TURF RENOVATION

A. Renovate existing turf.

B. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
2. Install new planting soil as required.

C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

E. Mow, dethatch, core aerate, and remove existing turf.

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 turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

J. Apply seed and protect with straw mulch as required for new turf.

K. Water newly planted areas and keep moist until new turf is established.

3.8 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

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 turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 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 initial and subsequent mowings to maintain the following grass height:

D. Turf Post fertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of not less than lb/1000 sq. ft. to turf area.

3.9 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: 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 and bare spots not exceeding 5 by 5 inches .
2. Satisfactory Sodded Turf: (NOT USED).

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.10 MEADOW

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

Do not use wet seed or seed that is moldy or otherwise damaged.

B. Sow seed at a total rate of as noted on plans.

C. Brush seed into top 1/16 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas from hot, dry weather or drying winds by applying peat or compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

E. Water newly planted areas and keep moist until meadow is established.

3.11 MEADOW MAINTENANCE

A. Maintain and establish meadow by watering, weeding, mowing (twice year), trimming, replanting, and performing other operations as required to establish a healthy, viable meadow. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and meadow damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep meadow and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and meadow-watering equipment to convey water from sources and to keep meadow uniformly moist.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over puddy or newly planted areas.
2. Water meadow with fine spray at a minimum rate of one inch per week for six week weeks after planting unless rainfall precipitation is adequate.

3.12 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.13 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove nondegradable erosion-control measures after grass establishment period.

SECTION 329300 – PLANTS

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. Execute the work of this Specification in accordance with applicable portions of:

1. Division 1 - General Requirements
2. Drawings L-001, L-101-104

1.2 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils.
3. Tree stabilization.

B. Related Sections:

1. Division 31 Section "Site Preparation" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
2. Division 32 Section "Turf and Grasses" for turf (lawn), sod (alternate to bid) and meadow planting, hydroseeding, and erosion-control materials.

1.3 ALLOWANCES

A. Allowances for plants are specified in Division 01 Section “Allowances.”

1. Perform planting work under quantity allowances and only as authorized. Authorized work includes: Unless specifically excluded hereinafter under RELATED SECTIONS: provide labor, materials, equipment and services necessary and incidental to complete work described by this Section's title shown above. Work includes, but is not necessarily limited to:
   a. Fine Grading.
   b. Providing and Placing all Off-site Topsoil and Planting Soil Backfill Mix required to complete Landscape Development Work.

c. Preparation of Planting Areas as required.
d. Furnishing and installing all Plant Material.
e. Furnishing and installing all Shredded Hardwood Bark Mulch
f. Furnish and install playground poured in place safety surface.
g. Furnish and install playground tile safety surface (swing area only)
h. Furnish and install playground equipment.
i. Maintenance of all Work until Final Acceptance (not less than 60 days).
j. Clean-up of Work Area as outlined in these specifications.

2. Notify Landscape Architect weekly of extent of work performed that is attributable to quantity allowances.
3. Perform work that exceeds quantity allowances only as authorized by Change Orders.

B. Work By Others;

1. Installation of Bituminous Parking Lots and Drives.
2. Installation of Curbs, Concrete Walks and Wheel Stops.
3. New School Building.
4. Site Furniture, Flag Poles

1.4 UNIT PRICES

A. Work of this Section is affected by unit prices specified in Division 01 Section "Unit Prices."

1. Unit prices apply to authorized work covered by quantity allowances.
2. Unit prices apply to additions to and deductions from Work as authorized by Change Orders.

1.5 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

Bare-Root Stock: 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 type and size of plant required.

E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a 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 type and size of plant required.

F. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

G. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

H. Finish Grade: Elevation of finished surface of planting soil.

I. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

J. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

K. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

L. Planting Area: Areas to be planted.

M. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

N. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

O. 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.

P. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

Q. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

R. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

S. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including soils.

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
2. Pesticides and Herbicides: Include product label and manufacturer's application instruction specific to the Project.
3. Plant Photographs: Include color photographs in either digital or 3- by 5-inch (76- by 127-mm) print format of each required species and size of plant material as it will be furnished to the 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 10 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: Contact Landscape Architect for review of plant material, based on information received above in product data. The Landscape Architect reserves the right to inspect trees and shrubs either at place of growth or at site before planting, for compliance with requirements for name, variety, size and quality. Provide trees and shrubs grown in a recognized nursery in accordance with good horticultural practice. Provide healthy, vigorous stock grown under climatic conditions similar to conditions in the locality of the project and free of disease, insects, eggs, larvae, and defects such as knots, sunscald, injuries, abrasions or disfigurement. Provide trees and shrubs of the sizes shown as specified. Trees and shrubs of larger size may be used, if acceptable to Landscape Architect, and if sizes of roots or balls are increased proportionately.
2. Mulch: one quart volume of each organic mulch required, in sealed plastic bags labeled with composition of materials by percentage of dry weight and source of mulch. Each Sample shall by typical of the lot of material to be furnished and provide an accurate representation of color, texture, and organic makeup.
3. Filter Fabric: 12 x12" sample, with manufacturer specifications.

1.7 INFORMATIONAL SUBMITTALS

A. Qualifications: The Landscape Work shall be done by a single firm specializing in landscaping work. Include list of similar projects completed, demonstration Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. General: Ship landscape materials with certificates of inspection as required by governmental authorities. Comply with governing regulation applicable to landscape materials.
2. Manufacturer's certified analysis of standard products.
3. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

C. Material Test Reports:

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1. Certification: For information only, submit 2 copies of certificates of inspection as required by governmental authorities, and manufacturers or vendor's certified analysis for soil amendments and fertilizer materials. Submit other data substantiating that materials comply with specified requirements.

D. Maintenance Instructions: Maintenance Instructions: Submit two copies of typewritten instructions recommending procedures to be established by the Owner for the maintenance of landscape work for one full year after completion or expiration of required maintenance period(s).

E. Provide two copies of warranty (See Item 1.11 for specific requirements).

F. Schedule of Work: For information only, submit 3 copies of tentative schedule to Owner and/or Owner's Agent along with Landscape Architect. Contractor shall keep all parties above apprised of any changes so that the Owner's Agent is aware of scheduled work at least 24 hours prior to said work being started.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Provide Professional Memberships.
2. Provide number of years' experience in Landscape Installation in addition to requirements in Division 01 Section "Quality Requirements"
3. Provide Field Supervision Installers experience. Note full time Supervisor to be on Project Site at all times when landscape installation is in progress.
4. Pesticide Applicator: Licensed

B. Provide Soil-Testing Laboratory Name and Qualifications.

C. Soil Analysis: For each un-amended soil type, furnish soil analysis and a written report by a qualified soil testing laboratory stating percentages of organic matter, gradation of sand, silt, and clay content; cation exchange capacity, deleterious material, pH, and mineral and plant nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
2. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Landscape Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
3. Report suitability of tested soil for plant growth.
   a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq ft or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
   b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

D. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1. Do not make substitutions: If specified landscape material is not obtainable, submit to Landscape Architect proof of non-availability and proposal for use of equivalent material. When authorized, adjustment of contract amount will be made.

E. Plant Material Observation: 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. Landscape Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Landscape Architect of sources of planting materials 14 days in advance of delivery to site.

F Hardscape Materials: Materials and methods of construction shall comply with American Society for Testing and Materials (ASTM). Installation shall be performed by skilled workmen with a satisfactory record of performance on completed projects of comparable size and quality. Do not change source of Hardscape Materials during the course of the work.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with State and Federal laws if applicable. Protect materials from deterioration during delivery, and while stored at the site. Materials shall be checked to ensure that no damages occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage and to protect against damage, weather, vandalism and theft.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers, and soil amendments with appropriate certificates.

C. Plant Materials:

1. Bare Root Stock: NOT USED.
2. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
3. Label at least one tree and one shrub of each variety with a securely attached waterproof tag bearing legible designation of botanical and common name.
4. Do not remove container grown stock from containers until planting time.
5. Handle planting stock by root ball.
6. Bulbs: NOT USED
7. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six (6) hours after delivery, set plants and trees in their appropriate conditions, protect from weather and mechanical damage, and keep roots moist.

a. Set balled stock on ground and cover ball with soil, peat moss, or other acceptable material.
b. Do not remove container-grown stock from containers before time of planting.

c. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary, to maintain root systems in a moist, but not overly-wet condition.

1.10 PROJECT CONDITIONS

A. Field Measurements: Installer must verify actual grade elevations, service and utility locations, i[illegible] components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work. Installer must observe the conditions under which work is to be performed, and notify the Landscape Architect of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to utilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:

1. Notify the Landscape Architect/ Construction Manager and Owner no fewer than seven days in advance of proposed interruption of each service or utility.
2. Do not proceed with interruption of services or utilities without Construction Managers and or Owner's written permission.

C. Planting Restrictions: Proceed with and complete the landscape work as rapidly as portions of the site become available, working within the seasonal limitations for each kind of landscape work required. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

D. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Landscape Architect before planting.

E. Planting Schedule: Prepare a proposed planting schedule. Schedule the dates for each type of landscape work during normal seasons for such work in the areas of the site. Correlate with specified maintenance periods to provide maintenance until acceptance by the Owner. Once accepted, revise dates only as approved in writing, after documentation of reasons for delay.

F. Coordination with Lawns: Plant trees and shrubs after final grades are established and prior to planting of lawns, unless otherwise acceptable to the Landscape Architect. If planting of trees and shrubs occurs after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.

G. Protect existing trees, shrubs and other hardscape elements against damage including trespassing, and erosion.

H. Protect all existing plant material in the area of this contract, whether inside or outside the contract limit line, against any damage, which in the opinion of the Landscape Architect will cause death or major retardation. Such material shall be replaced with same size and species by the Contractor at no additional cost should such damage occur.

I. Inspection of work will be made at the conclusion of work (at acceptance of the project). Submit written notice requesting final inspection at least 10 days prior to anticipated date.

1.11 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to the following:

    a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond contractor's control.
    b. Structural failures including plantings, falling or blowing over.
    c. Structural failures of tree stabilization structures, or stone energy dissipaters

2. Warranty periods will begin from the Date of installation completion (as determined by the Landscape Architect for a period of 12 months (one year).
3. Include the following remedial actions as a minimum.

    a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
    b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
    c. A limit of one replacement for each plant will be required except for losses or replacements due to failure to comply with requirements.
    d. Provide extended warranty for a period equal to the original warranty period, for replaced plant material.

1.12 MAINTENANCE

A. All planted trees, shrubs, groundcovers and annual flowers, shall be maintained until final acceptance of the completed contract. This shall be not less than 60 days. Maintenance shall include watering, cultivating, control of insects, fungus, and other horticultural operations necessary for the proper growth of all plants.

** END OF PART 1 **

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings L-101. and complying with ANSI Z60.1 and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders (unless otherwise indicated); tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; or with stem girdling roots will be rejected.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 "Standard for Nursery Stock" for types and form of plants required. Plants of a larger size may be used if acceptable to Landscape Architect, with a proportionate increase in size of roots or balls. Provide plant materials true to name and variety established by the American Joint Committee on Horticultural Nomenclature "Standardized Plant Names," Second Edition, 1942.

C. Deciduous Trees: Provide trees of height and caliper indicated or shown and with branching configuration recommended by ANSI Z60.1 for type and species required. Provide single stem trees except where special forms are shown or listed.

1. Provide balled and burlapped (B&B) deciduous trees.
2. Container grown deciduous trees will be acceptable in lieu of balled and burlapped deciduous trees subject to specified limitations of ANSI Z60.1 for container stock.

D. Deciduous Shrubs: Provide shrubs of the height shown or listed and with not less than the minimum number of canes required by ANSI Z60.1 for the type and height of shrub required.

1. Provide balled and burlapped (B&B), bare root (B.R.) or container deciduous shrubs as specified in plant list.
2. Container grown deciduous shrubs will be acceptable in lieu of balled and burlapped deciduous shrubs subject to the specified limitations for container grown stock.

E. Conifers and Broadleaved Evergreens: Provide evergreens of the sizes shown or listed. Dimensions indicate minimum spread for spreading and semi-spreading type evergreens and height for other types, such as globe, dwarf cone, pyramidal, broad upright and columnar. Provide normal quality evergreens with well-balanced from conforming with requirements for other size relationships to the primary dimension shown.

1. Provide balled and burlapped (B&B) or container grown evergreens as specified.
2. Container grown evergreens will be acceptable in lieu of balled and burlapped evergreens subject to the specified limitations for container grown stock.

Labeling: label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

G. If formal arrangements or consecutive order of plants is shown on plans, select stock for uniform height and

spread, and number the labels to assure symmetry in planting

H. Annuals and Biennials – Optional for Client determination. Provide healthy, disease-free plants, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery.

2. 2 INORGANIC SOIL AMENDMENTS

A. Ground Limestone: (To be incorporated into soil if soil pH value test shows low level of soil Ph which needs to be raised.). ASTM C 602, natural limestone containing not less than 85% of total carbonates, ground such that 90% passes a 10 mesh sieve and not less than 30% passes a 100 mesh sieve. Apply at the rate adequate to bring pH range up to 6.0 to 6.5.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur with a minimum of 99 percent passing through No.6 sieve and a maximum of 10 percent passing through No. 40 sieve.

C. Iron Sulphate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur. (To be incorporated into soil if soil pH value test shows high level of soil pH which needs to be lowered.) Iron Sulphate shall be applied at the rate adequate to bring pH range down to 6.0 to 6.5 and as per "Cornell Recommendations for Commercial Turf Grass Management".

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

G. Sand: Clean , washed, natural or manufactured and free of toxic materials.

H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: 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 1/2 inch sieve; soluble salt content of 4 to 8 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight

2. Feedstock: NOT USED

B. Peat Humus: FS Q-P-166 and with the texture and pH range OF 3.4 TO 4.8.

C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

D. Wood Derivatives: NOT USED

E. Manure: NOT USED

2.4 FERTILIZERS

A. Bonemeal: Commercial, raw, or steamed, finely ground; 4% nitrogen and 20% phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, Soluble; a minimum of 20% available phosphoric acid.

C. 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, phosphoric acid, potassium.

1. For All New Trees and Shrubs:

All trees and shrubs shall be fertilized with a controlled release 16-8 analysis fertilizer contained in a polyethylene perforated bag with micropore holes. The bag shall contain four (4) ounces minimum of water soluble fertilizer so as to be effective for eight (8) years.

The packets shall be placed equidistantly within the planting pit adjacent to the ball or root mass, but not in direct contact with roots. Placement depth shall be 12 to 18 inches. Packets shall not be cut, ripped or damaged. If it becomes necessary to remove and replace dead or unhealthy plants, damaged or broken packets shall be replaced with new packets.

A "Certificate of Compliance" must accompany the invoice showing quantity of material ordered, where material was supplied and shipped to, and its designed route and specific job application.

2. For lawns, provide fertilizer with not less than 4% phosphoric acid and not less than 2% potassium and the percentage of nitrogen required to provide not less than 1 lb. of actual nitrogen per 1000 sq. ft. of lawn area. Provide nitrogen in a form that will be available to the lawn during the initial period of growth.

D. Organic Fertilizer and Soil Conditioner: All trees and shrubs shall be treated with PHC Healthy Start which contains a blend of natural organic nutrients, proteins, sugars and other carbohydrates, humic acids, biostimulants and beneficial bacteria that enrich soil.

PHC Healthy Start is available from Plant Health Care, Inc., 440 William Pitt Way, Pittsburgh, Pennsylvania, 1-800-421-9[illegible] (Or approved equal)

2.5 PLANTING SOILS

A. TOPSOIL

Topsoil shall be from off-site sources. It shall be without admixture of subsoil or slag and shall be free of stones, lumps, plants or their roots, sticks and extraneous matter, and shall not be moved, placed or used while in a frozen or muddy condition.

Topsoil from off-site sources shall have an acidity range of pH 5.0 to 7.0 and shall contain not less than 5% organic matter as determined by the "Walkley-Black Method" (Colorimetric version). Sufficient limestone shall be added to

topsoil used to bring it to a range of pH 6.0 to pH 6.5.

Soil sample tests will be ordered by the Landscape Contractor and shall be made by a state or commercial laboratory using methods approved by the Associates of Official Agricultural chemists or the State Agricultural Experiment Station.

Such analysis will be paid for by the Contractor. Moving and placing of topsoil may be made after approval of the analysis by the Landscape Architect.

If approved, natural topsoil not having the hydrogen-ion value specified above may be amended by the contractor, at his own expense, to bring it within the specified limits. Topsoil shall meet the following mechanical analysis:

	Passing %	Retained %
1" Screen	100%	0%
1/2" Screen	97-100%	0-3%
No. 100 Mesh Sieve	60-40%	40-60%

There shall be a minimum of 4" of topsoil (after settlement) in shrub and perennial plantings, ground cover areas, and lawns or as called for on the drawings whichever is greater. 12" for annual plant beds.

B. Fill - NOT USED

C. Lightweight Or Structure Planting Soil – NOT USED

2.6 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of the following:

1. Mulch: Shall be 100% Double Hammered Milled Shredded Hardwood Bark Mulch. Mulch shall be free from any extraneous materials, and spread to a 3" depth minimum (after settlement). Contractor shall submit certification detailing content and source of mulch for Landscape Architect's approval.
2. Color: No artificial dyes or colorants will be allowed.

B. Compost Mulch: NOT USED

2.7 WEED-CONTROL BARRIERS – NOT USED

2.8 PESTICIDES

A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.9 TREE STABILIZATION MATERIALS

A. Stakes and Guys:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, treated softwood with specified wood pressu preservative treatment, free of knots, holes, cross grain, and other defects, (2" by 2" by 5'-0" min), pe ed a one end, 3 per tree.
2. Wood Deadmen: NOT USED
3. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twist d, 12 uge.
4. Guy Cables: Five-strand, galvanized-steel cable, with zinc-coated turnbuckles, a minimum o nches ng, with two 3/8 inch galvanized eyebolts.

B. Root-Ball Stabilization Materials: NOT USED

2.10 LANDSCAPE EDGINGS – NOT USED

2.11 TREE GRATES – NOT USED

2.12 MISCELLANEOUS LANDSCAPE MATERIALS

A. Anti-Desiccant: Emulsion type, film-forming agent similar to wa by Dow emical Co., or Wilt-Pruf by Nursery Specialty Products, Inc., designed to permit transpiration, b retard xce ve loss of moisture from plants. Deliver in manufacturer's fully identified containers and mix in accord with m ufacturer's instructions. All plants shall be sprayed with an anti-desiccant once in late Fall (November) and i e Winter (February).

B. Wrapping: Tree-wrap tape not less than 4" wide esi ed to prevent borer damage and winter freezing.

C. Filter Fabric: Filter weave 40/10 as manu tur by olon/Mirafi Group. (Or approved equal). Filter weave 40/10 is available from Ragen Associates. 2 arsen Rd., Iselin, NJ 08830, (732)602-9500 or (800)752-1010 outside NJ.

D. Playground Equipment complyi with proje requirements shall be manufactured by DuraMax Structures a Pla ore C pany 1 Chestnut Street, Chattanooga, TN 37402 or approved equal. (see Section 3.20).

E. Safety surface shall be ult Safety Surface as manufactured by No Fault Sport Group, LLC, 3112 Valley Creek Drive, Suite 2 Baton Roug A 70808. (see Section 3.20). (Or approved equal)

F. No Fault ety Tiles as are manufactured by ECORE International and sold exclusively by No Fault Sport Group, LLC a t thorized agents, 1-866-637-7678 or www.nofault.com. Any substitutions must be approved. (see Section 3.20)

** END OF PART 2 **

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, varnish, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install 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.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Apply anti-desiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
1. If deciduous trees or shrubs are moved in full leaf, spray with anti-desiccant at nursery before moving and again two weeks after planting.

E. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.3 PLANTING AREA ESTABLISHMENT

A. Rough grade will be left 4” below finished grade by others. Loosen subgrade of lawn areas to a minimum depth of 4”. Remove stones over 1” in any dimension and sticks, roots, rubbish and other extraneous matter and legally dispose them off Owner’s property. Limit preparation to areas, which will be planted promptly after preparation.

1. Spread topsoil to minimum depth required to meet lines, grades and elevations shown, after light rolling and natural settlement (4” after settlement). Place approximately 1/2 of total amount of topsoil required. Work into top of loosened subgrade to create a transition layer and then place remains of topsoil. Add specified soil amendments (as per Section 3.19-B of this specification) and mix thoroughly into the upper 4 inches of topsoil.

2. Where final grades are not indicated, finish grades shall be of uniform level or slope between points for whi elevations are given or from such points to existing grades, except that tops and bottoms of banks shall be round . Subgrade elevations shall be understood to be the specified depth below finished grades.
3. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface moistur to dry before seeding. Do not create a muddy soil condition.
4. Restore lawn areas to specified condition if eroded or otherwise disturbed after fine grading and prio

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine te re. Roll and rake, remove ridges, and fill depressions to meet finish grades.

C. Before planting, obtain Landscape Architect's acceptance of finish grading; resto planting as if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits with sides sl ping rd at a 5 degree angle. Excavations with vertical sides are not acceptable. Leave center bottom of excava slig ed at center to provide proper drainage. Ensure that root ball will sit on undisturbed base soil to prevent tling. Loosen hard subsoil in bottom of excavation.

1. For balled and burlapped (B&B) trees and shrubs, make ations least the equivalent of two and a half times as wide as the ball radius and equal to the ball depth, plus t llo ng allowance for setting of ball on a layer of compacted backfill: Allow for 6" setting layer of planting soil m ure.
2. Excavate at least 12 inches wider than root pre and deep enough to accommodate vertical roots for bare-root stock.
3. Do not excavate deeper than the depth of roo sured from the root flare to the bottom of the root ball.
4. If area under the plant was initially dug too ep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
5. Maintain required angles of ose of ad ent material as show on the Drawings. Do not excavate subgrades of adjacent paving, structures, ha scapes, or her new or existing improvements.
6. Maintain supervision of cava s duri working hours.
7. Keep excavations ered or e ise protected after working hours, overnight and when unattended by contractor's perso l.

B. Subsoil and topsoil remove m excavations MAY NOT be used as planting soil.

C. Obstruc Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encou ered cavations.

D. Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pla g pits.

E. ill exc ations with water and allow to percolate away before positioning trees and shrubs.

3. REE, SHRUB, AND VINE PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the tip-most root emerges from the trunk. After soil removal to expose the root flare, verify that the root ball still meets size requirements.

B. Remove stem girdling roots and kinked roots, Remove injured roots by cutting cleanly; do not break.

C. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare 3 inches above adjac finished grade.

1. During the placement of backfill place "Unique Fertilizer Packets" as specified in section 2.4 C as

	Types of Plants	No. of Packets
a.	Trees:	
	Over 4 inch caliper	4
	1 to 4 inch caliper	3
	Over 6 feet high	4
	3 to 6 feet high	3
	15 to 36 inches high	2
	Under 15 inches high	1
b.	Shrubs:	
	Over 3 feet high	3
	2 to 3 feet high	
	Under 2 feet high	

The packets shall be placed equidistantly within the planting pi adjacent to the ball or root mass, but not in direct contact with roots. Placement depth shall l 8 inches. Packets shall not be cut, ripped or damaged. If it becomes necessary to remove and repla dead o unhealthy plants, damaged or broken packets shall be replaced with new packets.

2. When excavation is approximat 2/ l wa thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. W ter again er placing final layer of backfill. Remove collar ropes only. Retain burlap on balls.

D. Set bare root stock on shion of pl g soil mixture. Spread roots, then carefully work backfill around roots by hand and puddle wi ater ul backfill layers are completely saturated. Plumb before backfilling and maintain plumb while working b n around roots and placing layers above roots. Set collar 1" to 2" above adjacent finish landscape gra es. Spread roots without tangling or turning up to surface. Cut injured roots clean, do not break.

E. Set cont rown stock as specified for balled and burlapped stock, except cut cans on two sides with an approved can cu er; re e bottoms of wooden boxes after partial backfilling so as not to damage root balls.

F. nting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope: the edge the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill e of the root ball.

G. D op of backfill to allow for mulching. For Spring planting, provide additional backfill berm around edge of excavations to form shallow saucer to collect water.

1. Note: Surface of all Shrub Beds shall be crowned or sloped as required to achieve a 3% minimum surface pitch and insure positive surface drainage.

H. Wrap tree trunks of 2" caliper and larger. Start at ground and cover trunk to height of first branches and securely attach. Inspect tree trunks for injury, improper pruning and insect infestation and take corrective measures required before wrapping.

3.6 MECHANIZED TREE SPADE PLANTING – NOT USED

3.7 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches, Do not prune for shape.

B. Prune, thin out and shape trees and shrubs in accordance with standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise directed by the Landscape Architect, do not cut tree leaders, and remove only injured or dead branches from flowering trees, if any. Prune shrubs to retain natural character and accomplish their use in the landscape design. Required shrub sizes are the size after pruning.

1. Remove and replace excessively pruned or misformed stock resulting from improper pruning.
2. Do not apply pruning paint to wounds.

3.8 TREE STABILIZATION

A. Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying: Stake trees of 3 inches through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and extend to the dimension shown on Drawings. Set vertical stakes and space to avoid penetrating root ball or root masses.
2. Use two stakes for trees up to 14 feet high and 1 1/2 inches or less in caliper; three stakes for trees less than 14 feet high and up to 4 inches in caliper. Space stakes equally around trees.
3. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

3.9 ROOT-BARRIER INSTALLATION – NOT USED

3.10 PLANTING IN PLANTERS – NOT USED

3.11 GROUND COVER AND PLANT PLANTING – NOT USED

3.12 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees and tree like shrubs in Turf Areas: Apply mulch ring of 3inch thick with 36 inch radius around trunks or stems. Do not place mulch within six inches of trunk or stems
2. Organic Mulch in Planting Areas: Apply three inches thickness of organic mulch or stone extending 12 inches beyond edge of individual planting pit or trench and over whole surface of plating area, and finish level with adjacent finished grades. Do not place mulch within three inches of trunks or stems.
3. Mineral Mulch in Planting Areas: Apply 3 inch average thickness of mineral mulch over whole surface area as shown on plans, and finish level with adjacent finish grades. Do not place mulch within 6 inches of trunks or stems.

3.13 EDGING INSTALLATION

A. Shovel-cut Edging. Separate mulched areas from turf areas with a 45 degree 4 to 6 inch deep, shovel cut edg

3.14 TREE GRATE INSTALLATION – NOT USED

3.15 PLANT MAINTENANCE

A. Begin maintenance immediately after planting. Maintain trees, shrubs and other pla until final ceptance, but in no case less than the following period: 60 days after planting.

B. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing mulch rest ng planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper g s or vert l position, and performing other operations as required to establish healthy, viable plantings. Spray treat a required to keep trees and shrubs free of insects and disease.

C. Fill in as necessary soil subsidence that may occur because set ng or o processes. Replace mulch materials damaged or lost in areas of subsidence.

D. Apply treatments as required to keep plant materials, plan ar , and soils free of pests and pathogens or disease. Use integrated past management practices whenev possible to minimize the use of pesticides and reduce hazards. Treatments include physical such as hosing off foliage, mechanical controls such as traps, and biological control agents.

E. Submit two copies of typewritten instruction commending procedures to be established by the Owner for the maintenance of landscape work f ne ear ubmit prior to the expiration of required maintenance period(s).

3.16 PESTICIDE APPLICATION

A. Apply pesticides a other che products and biological control agents in accordance with authorities having jurisdicti and anufacturer's written recommendations. Coordinate applications with Owner's operations and other roximity to the Work. Notify Owner before each application is performed.

B. Pre-Eme ent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accor with manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emerge erbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated we nd in accordance with manufacturer's written recommendations.

3.17 CLEA UP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. During landscape installation, store materials and equipment where directed.

B. Protect landscape work and material from damage due to landscape operations, operations of other contractors and trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.

C. After installation and before final inspection, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.18 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

3.19 PREPARATION OF PLANTING SOIL

A. Before mixing, clean topsoil of roots, plants, sods, stones, clay lumps and other extraneous material harmful or toxic to plant growth.

B. Mix specified soil amendments at required rates (derived from Topsoil Analysis Report). Amendments include the following:

1. For Trees and Shrubs (excluding coniferous ground cover): PHC Hearty Start 3-4-4 organic fertilizer/soil conditioner, shall be applied at 1/2 lb. per trunk diameter (cal.) inch for trees.

For shrubs as follows:

Plant Size	Rate Cups	Lbs	# Plant Bag
1 Gallon	1/2	[illegible]	100
5 Gallon	1	[illegible]	50
15 Gallon	2	1	25
24" Ball/Box	3	1 1/2	16
36" Ball/Box	5	2 1/2	10
42" Ball/Box	6	3	8
54" Ball/Box	8	4	6
72" Ball/Box	10	5	5

C. Planting Soil Mixture: Shall consist of one part off-site topsoil, as required, one part clean coarse builder's sand and one part humus. These shall be thoroughly mixed prior to any planting operations. The preceding shall be mixed with the soil amendments in Section 3.19 B.

D. Lightweight Soil Mixture: (NOT USED)

E. For pit and trench type planting, mix planting soil prior to back filling and/or placing stockpile at the site.

F. For planting beds, mix planting soil either prior to planting or apply on surface of topsoil and mix thoroughly before planting.

3.20 MISCELLANEOUS LANDSCAPE CONSTRUCTION

1. INSPECTION & ACCEPTANCE

A. When the landscape work is completed, including maintenance, the Landscape Architect will, upon request, make an inspection to determine acceptability. The landscape work may be inspected for acceptance in parts agreeable to the Landscape Architect, provided the work offered for inspection is complete, including maintenance, and that the area comprises a complete unit or area of substantial size.

B. Where inspected landscape work does not comply with the requirements replace rejected work and continue specified maintenance until re-inspected by the Landscape Architect and found to be acceptable. Remo rejected plants and material promptly from the project site.

** END OF PART 3 **
END OF SECTION

SECTION 330500 - COMMON WORK RESULTS FOR UTILITIES

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. Grout.
2. Flowable fill.
3. Piped utility demolition.

1.3 DEFINITIONS

A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

PART 2 - PRODUCTS

2.1 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi , 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.2 FLOWABLE FILL

A. Description: Low-strength-concrete, flowable-slurry mix.

1. Cement: ASTM C 150, Type I, portland.
2. Density: 115- to 145-lb/cu. ft..
3. Aggregates: ASTM C 33, natural sand, fine and crushed gravel or stone, coarse.
4. Water: Comply with ASTM C 94/C 94M.
5. Strength: 100 to 200 psig at 28 days.

PART 3 - EXECUTION

3.1 PIPED UTILITY DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.

C. If pipe, insulation, or equipment to remain is damaged in appearance or unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 GROUTING

A. Mix and install grout for equipment base bearing surfaces, pumps and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 330500

SECTION 334100 - SYNTHETIC TURF SUBDRAINAGE

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, equipment, and materials, and do work necessary to construct a [illegible] field, as indicated on the Drawings and as specified. Work shall include but shall not be limited to:

1. Earthwork Requirements
   a. Excavation, trenching, grading, backfilling, compaction to achieve subgrade.
   b. Laser grading.
   c. Disposal of spoil materials.
   d. Acceptance of Mass Subgrade by Playing Field Contractor.
      1) Mass Excavation performed by different contractor (if applicable).
      2) Playing Field contractor to review final submittals regarding mass excavation from General Contractor.
   e. Playing Field Contractor to perform finish subgrade per this contract.
   f. Grade elevation verification of finish Subgrade.

2. Drainage System Requirements
   a. Filter Fabric.
   b. Gravel drainage trench fill material.
   c. Panel drain pipe, collector pipe and fittings.
   d. Stone Base.
   e. Clean outs and inlet structures.
   f. Grade elevation certification of finished stone base installation.

1.2 RELATED DOCUMENTS

A. Review Contract Documents for requirements that affect work of this section. Specification Sections that directly relate to work of this section include, but are not limited to:

1. Section 312000 – Earth moving
2. Section 321313 – Concrete Paving
3. Section 321813 – Synthetic Turf Surfacing
4. Section 334100 – Storm Drainage Utility

1.3 REFERENCES

A. Comply with applicable requirements of the following standards. Should the standards conflict with other specified requirements, the most restrictive requirement shall govern.

1. American Association of State Highway and Transportation Officials (AASHTO).
   a. T 89 - Determining the Liquid Limit of Soils.
   b. T 90 - Determining the Plastic Limit and Plasticity Index of Soils.

2. American Society for Testing and materials (ASTM):
   a. D 3776 - Mass Per Unit Area (Weight) of Woven Fabric.
   b. D 3786 - Hydraulic Bursting Strength of Knitted Goods and Non-Woven Fabrics: Diaphragm Bursting Strength Tester Method.
   c. D 4491 - Water Permeability of Geotextiles by Permittivity.

d. D 4533 - Trapezoid Tearing Strength of Geotextiles.
e. D 4632 - Breaking Load and Elongation of Geotextiles (Grab Method).
f. D 4833 - Index Puncture Resistance of Geotextiles, Geomembranes, and Relat Products.
g. F 405 - Corrugated Polyethylene (PE) Tubing and Fittings.
h. F 449 - Subsurface Installation for Agricultural Drainage or Water Ta Co l
i. F 667 - 8, 10, 12 and 15-inch Corrugated Polyethylene Tubing and Fittin

3. Occupational Safety and Health Administration (OSHA).

1.4 SUBMITTALS

A. Manufacturer's Product Data: Submit manufacturer's specificati s and in llation instructions for all products in the playing field system, including certificat and o er data as may be required to show compliance with the Contract Documents.

B. Material samples. Submit three samples each of the foll ing:

1. Geotextile fabric approximately 12"x12".

2. Panel drain product approximately 1 in es in l th, full width.

3. Gravel Materials
a. 1 gallon samples of stone, t ing one, and gravel trench stone.
b. See Section 1.7 "Quality Cont ".

C. Supplier List: Submit list o procur and contracted suppliers of all materials required for this part of the Work.

D. Schedule: Work s edul all k described in this specification section. This schedule shall be regularly upd ed and su itted as progress continues throughout ultimate completion.

E. Shop Dra ngs:

1. Dam e Warranty.

2. Co uction details and installation instructions for all components of the system. Note any installation procedures that may deviate from the plans and specifications.

Drainage system components:
a. Pipe size and types
b. All Pipe fittings
c. Drain basins including invert connections and rim heights.
d. Drain basin and cleanout grates

F. Playing Field Contractor Reference List:

1. Up to date contact information.

2. Responsibility/scope of work for project.

3. Similar projects – full fields.

G. Playing Field Contractor Job Superintendent Resume:

1. Similar projects and references if different that Contractor reference list.

H. Subcontractor List: Submit list of key subcontractors for the project. Briefly describe the role of each as well as their experience with similar types of facilities such as being constructed in the Documents. This list should include but is not limited to:

1. Playing Field Base Installer / Contractor.

I. Manufacturer's Review: submit written statement, signed by Contractor and synthetic field surfacing installer stating that the Drawings and Specifications have been reviewed by qualified representatives of the materials manufacturer, and that they are in agreement that the materials and system to be used for synthetic field surfacing are proper and adequate for the applications shown.

J. Site Acceptance Statements:

1. Prior to beginning Work on subgrade of playing field areas: Submit a written statement signed by the General Contractor noting that the site has been reviewed and that documents showing compaction and specified elevations/planarity (if by others) have been reviewed. Note all discrepancies, conflicts or other issues. If none are found this should be noted in the statement. Upon acceptance, Work shall begin with the assurance that all work shall be warranted for the period as specified in these Documents.

K. Grade Verification: A certified survey by a State licensed surveyor shall be made of the in-place condition at the mass excavated subgrade, finish subgrade and finish stone base for conformance to specified elevations.

1.5 QUALITY ASSURANCE

A. All piping and appurtenances shall be new, clean and in accordance with material specifications, unless specifically noted on the plans.

B. Size and classification shall be shown on the plans or as specified herein.

C. The contractor who performs this work shall have installed five similar installations in the last three years. Submit complete list of projects, including project description, date of completion, and contact information. Comparable projects shall minimally include but not be exclusive to the following:

1. Laser grading (not GPS) experience for gravel and finished surface meeting the requirements for finish grade required in this Contract.

2. Installation of stone base and finished surface.

3. Full field installations.

4. Experience with testing protocols for stone base.

D. Grade Certifications: A certified survey by a DE State Licensed land surveyor shall be made at the top of the Finish Subgrade and at the top of the installed Stone base to verify conformance to specified final elevations. GPS survey laser equipment shall not be used for any finish elevation determination. Equipment mounted laser and hub or similar are required for playing field grading operations.

1.6 QUALITY CONTROL

A. Pre-bid: Materials Inspection and Testing:

1. Bidders are encouraged to:
   a. Pre-test gravel drainage materials with an independent Testing Agent prior to submitting a bid. This does not guarantee that the materials or source will be approved for construction.
   b. Pre-qualify any material deviating from that specified.
   c. All costs associated with pre-bid testing shall be borne by the bidder.

B. After Bid Award and Prior to construction: Submit samples of each of the following materials to establish Baseline specification and ratios for the remainder of the testing process.

1. Gravel Drainage Material: Provide a one-gallon sample from each proposed drainage source and for each type of gravel material to be used for testing. This could include:
   a. Gravel trench drainage material.
   b. Base Stone.
   c. Topping Stone.

C. During Construction: Submit samples of each of the following during mass production of gravel materials for performance testing and prior to shipping

1. Gravel Drainage/ Stone/Topping Stone Material:
   a. A minimum one-gallon sample for every 500 cubic yards of each material used shall be tested by the Testing Agent for general compliance with the established Baseline specifications.

D. Testing Agent:

1. Playing Field Testing Agent:
   a. The Testing Agent shall perform testing of the field system material components, including but not limited to stone, topping stone and gravel trench materials, as well as to certify the capability of the stone base course to meet permeability and stability requirements before construction.
   b. The Contractor shall hire a testing agent to certify and make recommendations regarding playing field materials. Playing Field Contractor shall notify the Owner regarding timing, scheduling and use of these agents.
   c. Agent shall be independent, A2LA accredited and insured.
   d. Potential Agents for Owner Consideration
   e. The Testing Agent is to report/submit test results as they are known and simultaneously to the Playing Field Contractor, the Owner and its representatives.

E. The Engineer shall recommend for owner approval or rejection based on results of the tests and recommendation of the Testing Agent.

PRODUCT DELIVERY

A. Take all required measures to ensure that all piping and related appurtenances are protected from damage.

B. Special care shall be exercised during delivery and storage to avoid damage to the products.

C. All materials shall be delivered and stored within the Contractor's work limits or in an area approved by the Owner.

D. All materials shall be stored in strict accordance with the manufacturer's recommendations.

E. Products that are damaged will be removed and replaced, unless the product can be repaired in an acceptable manner by the Contractor, at his expense.

F. Packaged Materials:

1. Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery and while stored at site. Store out of low lying or drainage areas.

G. Drainage Gravel and Stone Base:

1. Deliver tested and approved lots in clean, dry, shed and covered trucks to eliminate contamination during transportation. Place directly on playing field. Do not stockpile on site.

1.8 WARRANTY/GUARANTEE

A. General: Warranties / Guarantees specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and are in addition to and run concurrent with other warranties/guarantees made by the Contractor under requirements of the Contract Documents.

B. The following are inclusive in the term "Playing Field System" for provisions of the guarantee:

1. Working function of the drainage system.

2. All materials and products specified.

3. Drainage through the turf, infill and stone base shall be guaranteed to have a percolation rate of 6 inches per hour.

C. Playing Field Subsurface and Drainage System Installer Guarantee: The President/Principal of this System installer shall prepare and sign this document and it shall include the following:

1. Guarantee shall include removal and replacement of materials (parts and labor) not performing to the standards described to repair field at no cost to the Owner.

D. Contractor shall not be held liable for incidental or consequential damages.

E. The Warranty does not cover any defect, failure, damage caused by or connected with abuse, neglect, deliberate acts, acts of God, casualty or loads exceeding the Contractor's recommendations.

PART 2 - PRODUCTS

2.1 SPORTS FIELD SUBDRAINAGE SYSTEM

A. Underdrain Collector Pipe and Fittings:

1. General:
   a. All specific pipes are noted on the Contract Drawings.
   b. Review drawings for locations of perforated and non-perforated piping.
   c. Solid wall pipe shall be high-density polyethylene pipe (HDPE) and shall conform to the requirements of AASHTO M252 Type S for 4 to 10 inch diameters and AASHTO M294 or ASTM F2306 Type S for 12 to 60 inch diameters.
   d. Perforated pipe shall be double wall high-density polyethylene pipe (HDPE) and shall conform to the requirements of AASHTO M252 Type SP for 4 inch to 10 inch diameters and AASHTO M294, Type SP or ASTM F2306 for 12 inch to 60 inch diameters.
   e. HDPE Perforated pipe shall have Class 2 slotted perforations in accordance with AASHTO M252 and M294.
   f. Virgin material for pipe and fitting production shall be high density polyethylene conforming to the minimum requirements of cell classification 424420C for 4-inch to 10-inch diameters, and 435400C for 12 inch to 60-inch diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 5%.
   g. Provide drainage pipe complete with bends, reducers, adapters, couplings, collars, and joint materials.
   h. Solid wall pipe joints and fittings shall meet the watertight joint performance requirements of AASHTO M252, AASHTO M294, or ASTM F2306. 4-inch through 60-inch shall be certified according to the requirements of ASTM D3212. Gaskets shall be made of polyisoprene meeting the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable protective wrap to ensure the gasket is free from debris. A joint lubricant compatible with the manufacturer shall be used on the gasket and bell during assembly.
   i. Solid wall HDPE 12-inch through 60-inch diameters shall have a reinforced bell with a bell tolerance device. The bell tolerance device shall be installed by the manufacturer.
   j. Provided drainage pipe complete with all fittings such as bends, reducers, adapters, couplings, collars, and joint materials. Fittings and couplers for perforated HDPE pipe shall be split couplings or snap couplings manufactured by the same manufacturer as the corrugated HDPE.
   k. Manufacturer's certification according to AASHTO M252 and M294 shall be submitted to the Engineer prior to installation of the pipe.

   Products:
   a. Advanced Drainage Systems (ADS).
   b. Approved Equal.

B. Underdrain Panel Drains and Fittings:

1. General:
   a. Corrugated panel drain shall conform to the requirements for Class B Geocomposite as defined in ASTM D7001-06. This geocomposite product shall be composed of a flat pipe design consisting of a full circumference polyethylene core.
   b. All materials and fittings shall conform to ASTM D7001-06.
   c. The corrugated panel drain shall have a nominal thickness of 1-inch and a nominal width of 12-inch.
   d. The core shall have a minimum compressive strength of 7,500 psf.

e. Geotextile wrap shall not be used on panel drain.

f. Provided panel drain complete with all fittings such as bends, reducers, adapters, couplings, collars, and joint materials. All fittings shall be supplied by the same manufacturer as the panel drain.

2. Products:
   a. "AdvanEDGE" Pipe – Advanced Drainage Systems (ADS).
      1) www.ads-pipe.com/us
   b. Approved Equal.

C. Collector Pipe Inline Drainage Structures / clean outs and sized as per drawings

1. General:
   a. Inline structures only are to be used. Riser fittings are not allowed.

2. Products:
   a. Cleanouts
      1) Nyloplast Drain Basin.
   b. Grate
      1) Open Grate – H20 Pedestrian

3. Suppliers:
   a. Nyloplast-ADS
      1) www.ads-pipe.com/us.
   b. Approved Equal.

2.2 GEOTEXTILE FABRIC

A. General:

1. Provide at playing field subgrade and playing field drainage trenches.

2. The geotextile shall be a nonwoven sheet of plastic yarn as defined by ASTM D123 and conform to the criteria presented in the following table. These requirements shall be based on the Minimum Average Roll Value (MARV) which is defined as the value that can be expected, with 95% confidence, to be the minimum test average obtained on a roll sampled and tested in accordance with ASTM D4759.

3. Geotextile shall meet the requirements of AASHTO M288 except as modified herein.

Geotextile Class 1			
Physical Property	ASTM Procedure	Minimum Acceptance Criteria	
		English	Metric
Grab Tensile Strength	D 4632	200 lbs	890 N
Grab Elongation at Break	D 4632	50%	50%
Puncture Strength	D 4833	80 lbs	355 N
Mullen Burst Strength	D 3786	260 psi	1790 Kpa
Trapezoidal Tear	D 4533	80 lbs	355 N
Apparent Size Opening (AOS)	D 4551	70-100 US Std	150 – 212 um

		Sieve	

4. Product:
   a. Mirafi 180 N
      1) www.mirafi.com.
   b. Propex Geotex 801
      1) www.geotextile.com.
   c. Approved equal.

2.3 STONE BASE AND TOPPING STONE

A. The stone base shall conform to the turf vendor's standard specifications subject to the engineer's approval and meet the following gradation for AASHTO #57 Stone:

Sieve Size	**Percent Passing by Weight**
1 1/2" (37.5mm)	100
1" (25.4mm)	95-100
1/2" (12.7mm)	25-80
1/4" (6.35)	0-10
No. 8 (2.36mm)	0-5

B. The topping stone must conform to the turf vendor's standard specs, is subject to the Engineer's approval, and meets the following gradation:

Sieve Size	Percent Passing by Weight
1/2"	100
3/8"	90-100
	75-100
No. 8	35-75
No.16	10-55
No. 60	0-15
No. 200 (75mm)	0-4

C. All stone shall be angular. Rounded or river stone is not acceptable.

D. In no instance shall multiple quarry sources be used within a single playing field area.

E. Bridging Characteristics:

a) $3 < \frac{\text{D50 base stone}}{\text{D50 top stone}} < 6$ b) $\frac{\text{D85 top stone}}{\text{D15 base stone}} < 2$

F. Drainage Characteristics:

1. Permeability for base stone shall be greater than 20"/hr.

G. Top dressing Stone is allowed for use to level the finished surface of the base stone. Total allowable finish depth to be in the range of 1/2 to 3/4 inch.

H. The gravel should meet one or both of the following stability requirements:

1. Sulfate Soundness (C-88)
   a. Not to exceed 12% loss.

2. LA Abrasion (ASTM C131)
   a. Not to exceed 40.

I. Alternate Gravel Backfill for Drainage Collector trenches only: Clean crushed stone or washed gravel. Gravel shall meet one or both of the above stability requirements using the stated test methods.

1. Size criteria:
   a. 95% Passing a 1 inch sieve.
   b. No more than 10% passing a #10 mesh (2.0 mm) sieve.
   c. No more than 5% passing a #18 mesh (1.0 mm) sieve.

2. Installed below the stone material.

3. Must bridge with the stone material.

PART 3 - EXECUTION

3.1 EXAMINATION AND PROTECTION

A. Verification of Conditions: Examine areas and conditions under which all work of this Section is being performed. Commencement of work implies acceptance of all areas and conditions. Correct any and all conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

B. Protection of Work this Contract: Protect all on-going work, so as not to delay work due to weather or project related construction. This includes but is not limited to the use of tarps, geotextile, plywood and other protective measures.

C. Protection of Persons and Property: Provide all necessary measures to protect workmen and passersby. Barricade open excavations occurring as part of the work, as required by municipal or other authorities having jurisdiction.

Protect adjacent construction throughout the entire operation. Protect newly graded areas from destruction by weather or runoff. Protect structures, utilities, pavements, and other improvements from damage caused by settlement, lateral movement, undermining and washout.

D. Unanticipated Conditions: Notify the Engineer immediately upon finding evidence of previous structures, filled materials that penetrate below designated excavation levels, or other conditions which are not shown or which cannot be reasonably assumed from existing surveys and geotechnical reports. Secure the Engineer's instruction before proceeding with further work in such areas.

E. Installation of synthetic field surfacing shall be done only after excavation and construction work which might injure it has been completed. Damage caused during construction shall be repaired before acceptance.

F. The Contractor shall coordinate the installation of the synthetic field surface and the surrounding surfaces for optimum interface at all edges.

3.2 PLAYING FIELD SUBGRADE & FINISH SUBGRADE

A. Layout and Control:

1. Refer to Section 312000 Earthmoving for subgrade work.
2. Refer to drawings for playing field limits and layout.

B. Excavation or Fill to achieve subgrade / finish subgrade if found neces

1. Refer to Section 312000 Earthmoving for additional Eart rk requir ents.

C. Playing Field Subgrade:

1. General
   a. Playing Field Contractor shall per m all erati s necessary to bring the playing field area to the required tole ces.
   b. Subgrade shall mirror the fi ish el tion of the field surface in regards to slope except where note n the ings.
   c. Compaction shall meet % S ndard roctor
   d. Proofrolling of the subgrad requ d.
   e. Sufficient grading must be do ring the progress of the work so that the entire playing field all be well drained and free from water pockets.

2. Playing Field S rade ce Requirements: The final elevation of the finish subgrade shall be pl minus one half inch at any point on the field and on a 25 foot by 25 foot gri

3. Playing ield Subg de Elevation Certification: A certified survey by a State licensed land su eyo all be rformed at 25-foot grid centers to verify required grade and elevation lerances e finish subgrade. The digital survey document shall indicate spot eleva ns and tenth of foot contours and shall be submitted to the Engineer for review and oval prior to moving to next part of work.

D. Playing Field inish Subgrade

General
   a. After verification and approval of the subgrade, the Playing Field Contractor shall then proceed with the fine grading of the subgrade. All fine grade cutting, filling, and backfilling necessary to be performed on the subgrade to bring the playing field areas finish subgrade to the required tolerances.
   b. Finish subgrade shall mirror the final finish elevation of the field surface in regards to slope except where noted on the drawings.
   c. Compaction for the finish subgrade shall meet 90% Standard Proctor.
   d. Proof-rolling of the finish subgrade is required.
   e. Sufficient grading must be done during the progress of the work so that the entire playing field area shall be well drained and free from water pockets.

2. Playing Field Finish Subgrade Tolerance Requirements: The final elevation of the finish subgrade shall be plus or minus one quarter inch at any point on the field and on a 25 foot by 25 foot grid grade.

3. Playing Field Finish Subgrade Elevation Certification: A certified survey by a State licensed land surveyor shall be performed at 25-foot grid centers to verify required gr and elevation tolerances of the finish subgrade. The digital survey document shall in ate spot elevations and tenth of foot contours and shall be submitted to the Engin for review and approval prior to moving to next part of work.

3.3 TURF PERIMETER NAILER/ANCHOR

A. Install approved anchoring system at entire perimeter/edges of turf installatio

B. Install anchoring/nailing "collar" around other in place or installed item ick c ler boxes, etc.), as appropriate to installation sequencing.

3.4 DRAINAGE SYSTEM INSTALLATION

A. Collector Pipe Trenching:

1. Only perform trenching, drainage pipe in lation nd b kfilling operations that can be completed in one day. Exposed trenches th collap due to rain or other occurrences shall be widened and filled as spec or re d with subgrade materials, compacted, and retrenched.

2. Contractor to connect playing field inag ystem to site storm drainage, as indicated in the Drawings.

3. Excavate trenches f all p ng to a uniform depth and width, sufficiently wide enough to provide ample w ing r
   a. Minimum w of trench to be twice the pipe diameter.
   b. A con ons such as large cobbles or unstable conditions that may cause nch to integrity shall be reported to the Engineer immediately.

4. E avat enches nd conduit to depth indicated or required to establish indicated slope nd invert e ions and to support bottom of pipe or conduit on undisturbed soil.

5. ractor to remove or manipulate spoils from trenching excavation so that integrity of fi ed grade requirements is maintained prior to placing filter fabric.

B. Installation of Geotextile Filter Fabric:

1. Install filter fabric onto full extent of field, bottom and sides of trenches for collector drain piping.

2. Extend fabric a minimum of 12 inches past each side of top of trench on top of the subgrade.

3. The fabric shall be placed as smooth and wrinkle-free as possible.

4. All laps shall be at least thirty-six inches in width without tension, stress, folds, or creases.

5. At time of installation, fabric will be rejected if it has defects, ribs, holes, flaws, deterioration, or damage incurred during manufacture, transportation, handling, or storage. Damaged materials shall be removed and replaced at no additional cost to the Owner.

6. Install fabric to coordinate with trenching operation and other parts of the Work.

7. Sandbags or other devices may be used as required to hold the fabric in position during installation. Materials, equipment or other items shall not be dragged across the fabric nor be allowed to slide down slopes on the fabric.

8. Fabric shall be covered as soon as possible after placement to minimize exposure to sunlight and to other types of contamination such as surface run-off.
   a. Fabric shall not be exposed for more than 10 days.
   b. Fabric which becomes overly contaminated shall be removed and replaced with new fabric.

9. Contractor to temporarily fold fabric over at the tops of the trenches during construction to eliminate migration of soil materials into the gravel trenches. Just prior to installation of stone base, this fold shall be undone and fabric shall be laid over the finished subgrade. Should contamination of the gravel trench occur, Contractor shall remove contaminated material and replace with clean approved materials at cost to Owner.

C. Installation of Collector piping:

1. Lay perforated pipe directly on drainage stone layer in trench bottom in accordance with pipe manufacturer's recommendations.

2. Provide collars and couplings as required for installation of these lines as well as for connections to drainage structures and trench drains.

3. Install collector as indicated on drawings so that it connects to site structures or extends to limits indicated.
   a. Protect all exposed ends of pipe until connected to detention or storm sewer system by playing field Contractor or others.

4. Pipe laying work shall commence at the main collector line and shall proceed from low point of system to high point.
   a. Pipe shall be laid true to line and grade in such a manner as to assure a close concentric joint with the adjoining pipe.
   b. Protect any exposed ends of the pipe until final connections are made.
   After pipe installation has been observed by the Engineer, drainage material shall be placed around and over the pipe.

5. Install inline structures, drain inlets, catch basins per manufacturer's instructions.

6. After pipe installation has been observed by the Playing Field Designer/Engineer, approved drainage material shall be placed around and over the pipe to the top of the trench.
   a. If observation indicates poor alignment, debris, displaced pipe, infiltration or other defects, Contractor to take whatever steps are necessary to correct such defects prior to proceeding.

7. Installation of drain lines from ground boxes:
   a. Install drain lines from in ground boxes installed in the field area. Connect directly to field drainage system or minimally to the gravel perimeter trench.

8. Collector pipe Clean Out: A nyloplast or equal structure is to be used for the cleanout. Grate shall be placed flush with finish stone base when in the playing field or flush with finish grade when occurring outside of the playing field.

D. Drainage Fill:

1. Trenches:

a. Place approved drainage gravel fill material in the drainage trench in a single layer. Place material around drainage pipe until it is level with the surrounding subgrade. This shall be the stone unless otherwise approved prior to installation.

b. Contractor to consider temporarily covering top of open gravel trench with the geotextile material overlapping the top of the trench to reduce contamination of the gravel material.

E. Installation of Panel Drains:

1. Install panel drains per the manufacturer's written instructions.

2. The panel drains are to be installed directly over the top of the geotextile fabric.

3. Connect panel drains to collector/header piping using panel drain manufacturer provided fittings, per manufacturer instructions and as shown on the drawings.

4. Provide 48 hours notice to the Engineer to inspect the panel drains in place prior to covering.

F. Clean Out/End Cap: Grate shall be placed flush with finish stone base when in the playing field or flush with finish grade when occurring outside of the playing field.

G. Testing Drain Lines: The Contractor shall ensure that lines are in proper alignment and free flowing prior to placing the drainage gravel fill material. The Playing Field Designer/Engineer will observe portions of this process for general conformance of the specifications.

3.5 INSTALLATION OF STONE BASE/TOPPING STONE

A. Install only tested and approved material at a uniform depth.

B. Placement of the stone base shall proceed from a stable area next to the geotextile fabric and systematically worked outward onto the field area.

1. The cover material shall be pushed forward and not dumped onto the liner.

2. Laser operated equipment shall be utilized.

3. All equipment used in spreading or traveling on the cover layer shall exert low ground pressures and shall be approved by the manufacturer and Engineer.

4. During placement and spreading:

a. A minimum depth of 6 inches of granular material shall be maintained at all times between the fabric and wheels of trucks or spreading equipment.

b. Dozer blades, etc. shall not make direct contact with the fabric. If tears occur in the fabric during the spreading operation, the granular material shall be cleared from the fabric and the damaged area repaired as previously described.

c. All equipment traveling on the cover layer shall avoid making sharp turns, quick stops or quick starts.

d. Care shall be taken to not disturb, displace or damage the geotextile fabric or the drainage system.

e. Contractor shall install stone layer in such a way as to reduce separation of the fines and larger particles in the stone blend.

C. Placement of the Topping Stone: This stone layer shall be placed over the stone base at a finished depth as shown on the drawings to produce a level/smooth surface prior to the placement of synthetic turf. Due to possible drifting of this finish stone material into the stone layer below, more material may be required than the finished depth to eventually achieve finished grade elevations at the top of the finish stone layer and shall be considered as part of the overall quantity necessary.

1. Contractor shall install topping stone layer in such a way as to reduce separation of the fines and larger particles in the stone blend.

D. Finish grade for Stone Base and Top Dressing Stone:

1. Shall be verified using laser operated survey instrument with a tolerance of +/- one-quarter inch over 25 feet in any direction.

E. Stone base elevation verification: A survey of the finished elevation for the stone base is to be developed by a State licensed surveyor over the entire surface in a 25 foot grid. The survey shall be certified (signed) and submitted to the Owner and its representatives for approval prior to installing the synthetic turf. The survey shall indicate spot elevations and tenth of foot contours.

F. Perform 3 permeability tests, in 3 different locations of each field, using a dual ring infiltrometer on the finished topping stone prior to installing the finished surface.

1. All test results must be greater than 6 inches per hour.

3.6 PROTECTION

A. Protection of materials and work shall be the responsibility of the Contractor during installation and thru acceptance/substantial completion. All material damaged prior to acceptance shall be replaced at no cost to Owner.

END OF SECTION

SECTION 334200 – STORMWATER CONVEYANCE

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 gravity-flow, nonpressure storm drainage outside the building, with the following components:

1. Precast concrete manholes.
2. Trench drain
3. Storm drain pipe and appurtenances

1.3 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water. Pipe joints shall be at least watertight, unless otherwise indicated.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Storm drain pipe.

B. Shop Drawings: For the following:

1. Manholes: Include plans, elevations, sections, details, and frames and covers.
2. Catch Basins and Stormwater Inlets. Include plans, elevations, sections, details, and frames, covers, and grates.
3. Stormwater Detention Structures: Include plans, elevations, sections, details, frames and covers, design calculations, and concrete design-mix report.

C. Field quality-control test reports.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe, pipe fittings, and seals from dirt and damage.

B. Handle manholes according to manufacturer's written rigging instructions.

C. Handle catch basins and stormwater inlets according to manufacturer's written rigging instructions.

D. Handle downspout boots according to manufacturer’s written instructions.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager Owner no fewer than five days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Construction Manager's written permission.

B. Site Information: Perform site survey, research public utility records, and verify existing utility locations. Verify that Storm Drainage System piping may be installed in compliance with original design and referenced standards.

1. Locate existing Storm Drainage System piping and structures that are to be abandoned and closed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

2.3 PE PIPE AND FITTINGS

A. Corrugated PE Drainage Pipe and Fittings NPS 48 and Smaller: AASHTO M 252M, Type S, with smooth waterway for coupling joints.

1. Watertight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
2. Corrugated PE Pipe and Fittings NPS 12 to NPS 48: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
3. Watertight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

B. Corrugated PE Pipe and Fittings NPS 56 and NPS 60: AASHTO MP7, Type S, with smooth waterway for coupling joints.

1. Watertight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

2.4 REINFORCED CONCRETE PIPE:

1. Materials shall be in accordance with ASSHTO M-170.
2. Pipe class shall be Class III unless otherwise indicated on the drawings.
3. Joints to be tongue and groove.
4. Joining material may be either:

a. Portland cement mortar consisting of 1 part Portland cement, 2 parts sand and enough water to provide a workable mix, or
b. Bitumastic joint filler equal to Ram-Neck.

5. Joints shall be watertight under full flow conditions.

2.5 PVC GRAVITY SEWER PIPING:

1. Pipe and Fittings: ASTM F 679, T-2 wall thickness, PVC gravity sewer pipe with bell-and-spi ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

2.6 NONPRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition co ing, joining underground nonpressure piping. Include ends of same sizes as piping to be joined nd co sion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Concrete Pipes: ASTM C 443, rubber.
2. For Dissimilar Pipes: ASTM D 5926, PVC or other mat al compa e with pipe materials being joined.

2.7 MANHOLES

A. Precast Concrete Manholes: ASTM C 478, preca reinf oncrete, of depth indicated with provision for rubber gasket joints.

1. Base Section: 8-inch minimum thickness for slab and 5-inch minimum thickness for walls and base riser section, and havi eparate base slab or base section with integral floor.
2. Riser Sections: 5-inch mi mum hickness; 48-inch diameter, and lengths to provide depth indicated.
3. Top Section: Eccentric co , unless concentric cone or flat-slab-top type is indicated. Top of cone to match grad
4. Grade Rings: P vide 2 3 re orced concrete rings, with 12 maximum inches total thickness and match 24-i n diamete ame and cover.
5. Gaskets: AST C 443, rub er.
6. Steps: C st into ri , and top sections sidewall at 12-to 16-inch intervals.
7. Pipe onnecto : ASTM C 923, resilient, of size required, for each pipe connecting to base secti
8. Channe Bench: Concrete or Brick.
9. Coat Exte Surface with two (2) coats of coal-tar epoxy, 15 mil. Minimum thickness.

B. hole Steps: Wide enough for a man to place both feet on one step and designed to prevent lateral slipp off the step.

1. Material: Steel-reinforced plastic.
Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, heavy-duty, ductile iron, 24-inch inside diameter by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch-diameter cover, indented top design, with lettering "STORMDRAIN" cast into cover.

2 CATCH BASINS & INLETS

A. Standard Precast Concrete Catch Basins & inlets: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

1. Catch basins & inlets shall be according to the local utility standard as noted on the structure schedule.

1. All materials for catch basins, steps, frames and grates, curb inlets and other appurtences and incidentals shall conform to Section 708 of DelDOT Specifications and Standard Details for structures noted as DelDOT structures on the plans.

B. Standard PVC Surface Drainage Inlets and In-Line Drains as indicated on the drawings.

1. Ductile Iron Grates shall be considered an integral part of the surface drainage structure and shall be furnished by the same manufacturer.
2. Structures shall be as manufactured by Nyloplast a division of Advanced Drainage Systems, Inc. or approved equal.

2.9 STORMWATER DETENTION STRUCTURES

A. Cast-in-Place Concrete, Stormwater Detention Structures: Construct of reinforced concrete bottom, walls, and top; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.

1. Ballast: Increase thickness of concrete, as required to prevent flotation.
2. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from top of structure to finished grade is less than 36 inches.

B. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service Include indented top design with lettering "STORM SEWER" cast into cover.

2.10 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

a. Invert Slope: 1 percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

a. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.11 POLYMER-CONCRETE, CHANNEL DRAINAGE SYSTEMS

A. General Requirements for Polymer-Concrete, Channel Drainage Systems: Modular system of pre- polymer-concrete channel sections, grates, and appurtenances; designed so grates fit in channel recesses without rocking or rattling. Include quantity of units required to form total lengths indicated.

B. Basis-of-Design Product: Subject to compliance with requirements, provide ACO Klassik KS100S sloped channel with ADA compliant black ductile iron "wave" pattern grate (Class C) and in-line catch basins at locations shown on the plans, or approved equal product. Provide ACO Sport system 4000 with in-line catch basins and ADA compliant black polyethylene slotted grates for softball field at the locations shown on the plans.

C. Sloped and Neutral Invert, Polymer-Concrete Systems:

1. Channel Sections:

a. Interlocking-joint, precast, modular units with end caps.
b. 4-inch inside width and deep, rounded bottom. Sloped channels shall have a built-in invert slope of 0.6 percent. Provide outlets in quantities, sizes, and locations indicated. Bottom outlets are to be used unless shown otherwise. Outlets shall include fitting required to transition from oval to round. Klassik system shall provide V-shaped profile.
c. Extension sections as necessary for required depth.
d. Frame: Include integral stainless steel frame for Klassik systems.

2. Grates:

a. Manufacturer's designation ACO Type with ADA compliant slotted openings suitable for use in pedestrian applications that fit recesses in channels.
b. Grates shall be 'QuickLok' locking and removable for easy access to the channel in order to maintain and clean the system.
c. Material: Ductile Iron in plaza areas; Polyethylene at Softball field.

3. Covers: Solid gray iron if indicated.
4. Locking Mechanism: Manufacturer's standard locking, removable device for securing grates to channel sections.
5. In-line catch basins will accompany each drainage system.

a. In-line catch basins compatible with each series system shall be provided. Eight shall be provided around the 400m running track. Four shall be provided at the Auxiliary stadium. Three each shall be provided at Competition baseball/softball fields as shown (including at the outfall location. Klassik pedestrian systems shall include a minimum of one catch basin per system at each outfall location or as recommended by the manufacturer.
b. Drill-out features for Schedule 40 4" and 6" pipes shall be provided.
c. Shall include trash bucket and removable cover to collect debris washed into the system.

2.12 CLEANOUTS

A. Cast-Iron Cleanouts:

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

   a. Josam Company.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.
   d. Tyler Pipe.
   e. Watts Water Technologies, Inc.
   f. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

2. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or hub spigot connection and countersunk, tapered-thread, brass closure plug.
3. Top-Loading Classification(s): Heavy Duty.
4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. Plastic Cleanouts:

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

   a. Canplas LLC.
   b. IPS Corporation.
   c. Nyloplast, a division of Advanced Drainage Systems, Inc.
   d. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   f. Zurn Light Commercial Products Operation; Zurn Plumbing Products Group.

2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING APPLICATIONS

A. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.

   a. Flexible or rigid couplings for same or minor difference OD pipes.

   b. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.

   c. Join dissimilar pipe materials with nonpressure-type flexible or rigid couplings.

B. Gravity-Flow, Nonpressure Sewer Piping: Use the following pipe materials for each size range and material as indicated on drawings:

1. NPS 4 and NPS 36 Corrugated PE drainage pipe and fittings, watertight couplings, and coupled joints.
2. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76, with groove and tongue ends.

3.3 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general locati and arrangement of underground storm drainage piping. Location and arrangement of piping layout e design considerations into account. Install piping as indicated, to extent practical. installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbrok ontinuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, slee , and uplin according to manufacturer's written instructions for use of lubricants, cements, and ot installati requirements.

C. Install manholes for changes in direction unless fittings are indicated. U fitti fo anch connections unless direct tap into existing stormdrain system is indicated.

D. Install proper size increasers, reducers, and couplings wh re di ent siz or materials of pipes and fittings are connected. Reducing size of piping in direction f low i ted.

E. Tunneling: Install pipe under streets or other obstr tio that ca t be disturbed by tunneling, jacking, or a combination of both.

F. Install gravity-flow, nonpressure drainage piping acc ling the following:

1. Install piping pitched down in of flow, at minimum slope of 1 percent, unless otherwise indicated.
2. Install piping below frost lin
3. Install corrugated steel piping a ding to ASTM A 798/A 798M.
4. Install nonreinforced sew iping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manua
5. Install reinforced- ncrete sew piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation M nua
6. Install PE orrugated piping according to CPPA's "Recommended Installation Practices for Corrug d Poly ylene Pipe and Fittings."

3.4 PIPE JOINT CO TRUCTION

A. ic pipe joint construction is specified in Division 33 Section "Common Work Results for Utilities." W specific joint construction is not indicated, follow piping manufacturer's written instructions.

Join gra y-flow, nonpressure drainage piping according to the following:

Join nonreinforced-concrete sewer piping according to ASTM C 14 and ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
2. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
3. Join dissimilar pipe materials with nonpressure-type flexible or rigid couplings.
4. Join corrugated PE piping according to CPPA 100 and the following:
   a. Use watertight couplings for Type 1, watertight joints.

3.5 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections according to ASTM C 891.

3.6 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.7 STORMWATER INLET AND OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicate

B. Install outlets that spill onto grade, anchored with concrete, where indicated

C. Install outlets that spill onto grade, with flared end sections that ma pip wher icated.

D. Construct energy dissipaters at outlets, as indicated.

3.8 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 31 18R

3.9 CONNECTIONS

A. Connect nonpressure, gravity-flow e piping in building's storm building drains specified in Division 22.

3.10 CLOSING ABANDONED STORM AINAGE SYSTEMS

A. Abandoned Piping: C se open ds o abandoned underground piping indicated to remain in place. Include closures stron enough to thstand hydrostatic and earth pressures that may result after ends of abandoned pipin have en close Use either procedure below:

1. Clos pen en of piping with at least 8-inch- thick, brick masonry bulkheads.
2. Close er nds of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable size and type of material being closed. Do not use wood plugs.

B. andoned Manholes and Structures: Excavate around manholes and structures as required and use one pr dure below:

1. move manhole or structure and close open ends of remaining piping.
Remove top of manhole or structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

Backfill to grade according to Division 31 Section "Earth Moving."

11 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.12 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between stru
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspection until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfacto

B. Test new piping systems, and parts of existing systems th ave b alte d, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service b ore i tion a d approval.
2. Test completed piping systems according auth rities aving jurisdiction.
3. Schedule tests and inspections by authoritie ving j sdiction with at least 24 hours' notice.
4. Submit separate report for each test.

3.13 CLEANING

A. Clean interior of piping of dirt and nuous materials. Flush with potable water.

END OF SECTION 334100

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