SPECIFICATIONS

Volume 3 of 3

(DESIGN DEVELOPMENT PHASE)

for

BLOOMFIELD PUBLIC LIBRARY

PROSSER LIBRARY

1 TUNXIS AVENUE
BLOOMFIELD, CT 06002

STATE PUBLIC LIBRARY CONSTRUCTION GRANT 011P-SC-21

October 7, 2022

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TECHNOLOGY, PHYSICAL SECURITY AND AUDIO-VISUAL NARRATIVE **DAG**
BUDGETARY ESTIMATES FOR TECHNOLOGY, AV & SECURITY **DAG**

SECTION 260500 - ELECTRICAL GENERAL CONDITIONS

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 LEED BUILDING GENERAL REQUIREMENTS

A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED (Leadership in Energy and Environmental Design) Green Building Rating System NC, Version 4.0, Silver rating. Specific project goals that may impact this area of work including, but not limited to: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the sections below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the stated LEED BUILDING Performance Criteria.

1.3 DESCRIPTION

A. Related Work Specified Elsewhere:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section..
   2. This section applies to certain sections of Division 1, Division 23, "Mechanical". This section applies to all sections of Division 26, "Electrical," of this project specification unless specified otherwise in the individual sections.
   3. Temporary Facilities and controls are specified in Section 01 50 00. Cooperate in ensuring adequate protection.
   4. General material, equipment and workmanship standards are specified in Section 01 60 00.
   5. Finished painting is specified in section 09 91 00.
   6. Access doors and panels to be installed in finished surfaces are specified in Section 08 31 13.
   7. Cutting and patching, chases, furred spaces, trenches, covers, pits, foundations and other construction required in conjunction with the work under this Division is specified in Section 01 73 29.

1.4 DRAWINGS AND COORDINATION

A. It is not the intention of the drawings to show every item, piece of equipment and detail. Provide complete, operating systems.

B. Install work as closely as possible to layouts shown on drawings. Modify work as necessary to meet job conditions and to clear other equipment. Consult Architect before making changes which affect the function or appearance of systems.

C. Dimensions, elevations and locations are shown approximately. Verify actual conditions in the field.

D. Owner, Architect, and Engineer reserve the right to order changes in layout of such items as switches, receptacles, and fixtures if such changes do not substantially affect costs and if affected items have not been fabricated or installed.

E. In some cases, drawings are based upon products of one or several manufactures as listed on the Contract Documents. This contractor shall be responsible for modifications made necessary by substitution of products of different manufacturers.

F. Do not install part of a system until all critical components of the system and related systems have been approved. Coordinate parts of systems to ensure proper operation of the entire system.

G. Install products in accordance with manufacturer's written instructions. Notify Engineer if Contract Documents conflict with manufacturer's instructions. Comply with Engineers interpretations.

H. Provide brackets, supports, anchors and frames required for installation of work specified herein.

1.5 CODES AND STANDARDS

A. The Codes and Standards listed below apply to all Work. Where Codes or Standards are mentioned in these Specifications, follow the latest edition or revision.

B. The current adopted editions of the following State or local Codes apply:
1. 2021 International Building Code (IBC) by the ICC
2. 2021 International Mechanical Code (IMC) by the ICC
3. 2021 International Plumbing Code (IPC) by the ICC
4. 2020 NFPA 70 National Electrical Code (NEC) by NFPA
5. 2021 International Energy Conservation Code (IECC) by the ICC
6. 2017 ICC A117.1 Accessible and Usable Buildings and Facilities by the ICC
7. 2021 International Fire Code (IFC) by the ICC.
8. 2021 NFPA 101 - Life Safety Code by the NFPA
9. 2021 NFPA 1 - Fire Code by the NFPA

C. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.

D. Include in the Work, without extra cost to the Owner, any labor, materials, testing, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on Drawings and/or specified.

1.6 PERMITS AND FEES

A. Give all necessary notices, obtain all permits; pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the Work. File all necessary Drawings, prepare all Documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspections for Work and deliver a copy to the Engineer before request for acceptance and final payment for the Work.

1.7 REFERENCES

A. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.

B. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 1993 (and Revision 1,2,3).

C. NEMA ICS 6 - National Electrical Manufacturers Association; 1993 Enclosures for Industrial Control and Systems

D. NEMA MG 10 - National Electrical Manufacturers Association; 1983; (R 1988) Energy Management Guide for Selection and Use of Polyphase Motors.

E. NEMA MG 11 - National Electrical Manufacturers Association; 1977; (R 1992) Energy Management Guide of Selection and Use of Single-Phase Motors.

F. NFPA 70 - National Electrical Code; National Fire Protection Association; 2005.

G. SSPC-Paint 15 - Steel Joist Shop Paint; Society for Protective Coatings; 1991 (Part of Steel Structures Painting Manual, Vol. Two).

H. IEEE 100 - 1992 Dictionary of Electrical and Electronics Terms.

I. IBC 2003, Structural Loads, Seismic bracing and restraints.

1.8 DEFINITIONS

A. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

B. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

C. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

1.9 EQUIPMENT DEVIATIONS

A. Where the Contractor proposes to deviate (substitute or provide an equivalent) from the equipment or materials as hereinafter specified, he shall do so by making a request in writing within 60 days from the Award of Contract. The Contractor shall state in his request whether it is a substitution or an equivalent to that specified, and the amount of credit involved. A copy of said request shall be included in the Base Bid with manufacturer's equipment cuts.
   1. The Base Product Specification shall be based on using the materials and equipment as specified and scheduled with no exceptions. Equipment Manufacturers Scheduled on Drawings are considered Base Product Specification and any other acceptable manufacturers listed in the specifications is considered an equivalent manufacturer to the Base Product Specification. Unlisted manufacturers are considered a substitution and equipment deviation and subject to the requirements for equipment substitution and deviation. When any alternate manufacturer does not qualify acceptable, as determined by the Engineer, provide the Base Bid manufacturer at no additional cost to Owner.
   2. Where an equivalent manufacturer is listed in the specifications, it may or may not indicate that there is an equal product available. Any products must meet all criteria of the Base Product Specification as determined by the Engineer.

B. Substitutions and Equipment Deviations will not be considered if they have a direct bearing on the changing or revising of Contract Documents or if it involves other Contractor's scope of work or thier equipment. Coordination with all trades is required and must be acceptable to all other involved Contractors.

C. Substitutions may be considered for one of the following:
   1. Substitution for Cause: Changes proposed by the Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of warranty terms.
   2. Substitutions for Convenience: Changes proposed by the Contractor or Owner that are not required in order to meet other Project requirements, but may offer advantage to either the Owner or Contractor.

D. In these Specifications and on the accompanying Drawings, one or more makes of materials, apparatus or appliances may have been specified for use in this installation. This has been done for convenience in fixing the standard of workmanship, finish and design required for installation. In the event that only one (1) manufacturer of a product is specified and it is found that the manufacturer has discontinued the product, the Contractor shall use an acceptable equivalent product that meets the requirements of an equivalent product, as noted below, and has all the features of the originally specified product. The details of workmanship, finish and design, and the guaranteed performance of any material, apparatus or appliance which the Contractor desires to deviate for those mentioned herein shall also conform to these standards.

E. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for the Engineer's review.

F. Where two or more names are given as equivalents, the Contractor must use the specified item or one of the named equivalents. Where one name only is used and is followed by the words "or acceptable equivalent", the Contractor must use the item named or he may apply for an equipment deviation through the prescribed manner in accordance with this Specification.

G. Equipment, material or devices submitted for review as an "accepted equivalent" shall meet the following requirements:
1. The equivalent shall have the same construction features such as, but not limited to:
2. Material thickness, gauge, weight, density, etc.
3. Welded, riveted, bolted, etc., construction
4. Finish, undercoatings, corrosion protection
5. The equivalent shall perform with the same or better operating efficiency.
6. The equivalent shall have equal or greater reserve capacity.
7. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
8. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as AMCA or ARI labels.

H. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required therefore shall be prepared by the Designers of Record at the expense of the Contractor and at no additional cost to the Owner.

I. Where such accepted deviation or substitution requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit and equipment from that specified or indicated on the Drawings, the Contractor shall, with the acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the substitution.

J. The Engineer shall determine if an "accepted equivalent" to a manufacturer listed in the Specifications is considered acceptable.

1.10 SUBMITTALS

A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.

B. Provide manufacturer's ORIGINAL printed product data, catalog cuts and description of any special installation procedures. Photocopied and/or illegible product data sheets shall not be acceptable. All product datasheets shall be highlighted or stamped with arrows to indicate the specific components being submitted for approval.

C. Submittals shall include the manufacturer's name, trade name, place of manufacture, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and technical paragraph reference. Submittals shall also include applicable federal, military, industry, and technical society publication references, and years of satisfactory service, and other information necessary to establish contract compliance of each item to be provided. Photographs of existing installations are unacceptable and will be returned without approval.

D. Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts. Handwritten and typed modifications and other notations not part of the manufacturer's preprinted data will result in the rejection of the submittal. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified for certificates of compliance.

E. Submit drawings a minimum of 14 inches by 20 inches in size using a minimum scale of 1/8 inch per foot except as specified otherwise. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

F. Where installation procedures or part of the installation procedures are required to be in accordance with manufacturer's instructions, submit printed copies of those instructions prior to installation. Installation of the item shall not proceed until manufacturer's instructions are received. Failure to submit manufacturer's instructions shall be cause for rejection of the equipment or material.

G. Submit manufacturer's certifications as required for products, materials, finishes, and equipment as specified in the technical sections. Certificates from material suppliers are not acceptable. Preprinted certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance.

H. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), Underwriters Laboratories Inc. (UL), and Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.

I. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.11 QUALITY ASSURANCE

A. Material and Equipment Qualifications
   1. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

B. Regulatory Requirements
   1. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70.

C. Alternative Qualifications
   1. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

D. Service Support
   1. The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

E. Manufacturer's Nameplate
   1. Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

F. Modification of References

1. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Building Official or Inspector and/or Fire Marshal.

G. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

H. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of experience.

I. Design Seismic bracing and restraints under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in Connecticut.

J. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1.12 SEISMIC RESTRAINT

A. General: This project is in a seismic zone per State and/or Local Codes and Ordinances and all materials and equipment shall be installed, supported, and seismically restrained accordingly. Verify current seismic requirements based on project location and with Code requirements.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where the Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of vibration isolation bases and seismic restraints that are similar to those required for this Project in material, design, and extent.

C. Shop Drawings: Show designs and calculations, certified by a professional engineer, for the following:
1. Design Calculations: Calculations for selection of vibration isolators, design of vibration isolation bases, design of seismic supports and selection of seismic restraints for all equipment and materials.
2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to the structure and to the supported equipment. Include auxiliary motor slides and rails, and base weights.
3. Seismic Restraint Details: Detail fabrication and attachment of restraints, supports and snubbers.
4. Seismic Separation Assemblies: Refer to the Architectural and/or Structural drawings for locations of seismic joints.

D. Installation: Installation shall be carried out in strict accordance with the Seismic Engineer's submittal, current Code, accepted standards and the equipment and material manufacturers' recommendations.

1.13 COORDINATION WITH OTHER DIVISIONS

A. Carry out all work in conjunction with other trades and give full cooperation in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the General Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, access doors, etc. required by other trades, and to allow for serviceable access to equipment.

B. Mechanical contractors' shall initiate coordination drawings and sections clearly showing how the work is to be installed in relation to the work of other trades, at no extra charge to the Owner. The Contractors' shall prepare coordination drawings at a scale no less than 1/4"=1'-0", showing the work of all trades, including but not limited to, the following: proposed ductwork installation in detail, including ceiling heights, approved structural steel shop drawings, duct heights, access doors, light fixtures, registers and diffusers, sprinkler piping and heads, electrical distribution conduits, wires, panels and any other electrical work which may conflict with the sheet metal ducts or piping, waste and vent piping, water piping, storm piping, and rain leaders. Provide elevation details showing connections and equipment layout and configuration based on approved submittals. Each shall use a different color code. A coordination meeting of all Contractors involved is then to be held and all possible conflicts are to be resolved. All trades shall sign acceptance of the drawings and then shall submit two (2) prints of each drawing to the Engineer for record.

C. Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference. In general, ductwork, heating piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer regarding the arrangement of work, which cannot be agreed upon by the Contractors, will make final decisions. Service of equipment will take precedence.

D. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment.

E. If work is installed before coordinating with other Divisions or so as to cause interference with work of other Sections, the Contractor causing the interference will make necessary changes to correct the condition without extra charge to the Owner.

F. Initial contact and coordination has been conducted with utility entities for the purpose of the preparation of Bid Documents. The Contractor shall coordinate all final specific utility requirements.

1.14 PRE-INSTALLATION MEETING

A. Convene one week before starting work of this section.

1.15 PROJECT CONDITIONS

A. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

B. Sequence installation to conform with the project phasing indicated on the Architectural drawings.

1.16 WARRANTY

A. See Section 017700 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a one year period after Date of Substantial Completion.

1.17 OPERATING INSTRUCTIONS

A. Submit text of posted operating instructions for each system and principal item of equipment as specified in the technical sections. The operating instructions shall include the following:
   1. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
   2. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
   3. Safety precautions.
   4. The procedure in the event of equipment failure.
   5. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

B. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.18 ELECTRICAL REQUIREMENTS

A. Electrical installations shall conform to ANSI C2, NFPA 70, and requirements specified herein.

B. Wiring and Conduit
   1. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for field-installed equipment, and motor control equipment, the conduit and wiring connecting such assemblies, or other power sources to equipment. Power and Control wiring and conduit shall be provided under Division 26 and shall conform to the requirements of the section specifying the associated equipment.

C. New Work

1. Provide electrical components of mechanical equipment, such as motors, motor starters, control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors shall not be permitted. The interconnecting power wiring and conduit, control wiring and conduit, the motor control equipment and the electrical power circuits shall be provided under Division 26, except internal wiring for components of packaged equipment shall be provided as an integral part of the equipment.
    a. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

D. Instruction To Owners Personnel
1. Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Owner personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Owner for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instructions to acquaint the operating personnel with the changes or modifications. Instructions and/or training shall be video taped. Provide the owner with two copies of the video tape prior to project close out.

E. Lockout Requirements
1. Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147. Mechanical isolation of machines and other equipment shall be in accordance with requirements of Division 23, "Mechanical."

1.19 THROUGH-PENETRATION FIRESTOP SYSTEMS

A. Refer to Division 7 Specification for additional and more specific information.

B. Fire-stopping systems shall be submitted as shop drawing.

C. Penetrations through fire-rated walls, ceiling or floors and penetrations through smoke barriers, smoke resistive construction, and construction enclosing compartmentalized areas involving both empty openings, openings containing penetration items, and openings due to flue decks shall be sealed with a U.L. approved fire-stop fitting classified for an hourly rating equivalent to the fire rating of the wall, ceiling or floor.

D. Thruwall and floor seals shall be used to provide a positive means of sealing pipes or ducts which pass through the concrete foundation of a structure below grade or below ground water level. Seals shall also be used at entry points through concrete walls or floors which must be sealed.

1.20 COMMISSIONING

A. Where indicated in the equipment or commissioning specifications, engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 01 91 13 - General Commissioning Requirements.

B. Complete installation, startup checks and functional tests according to Section 01 91 13 - General Commissioning Requirements and manufacturers written instructions.

C. Operational Test: After electrical system has been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new ones and repeat the start up procedure.

D. Verify that equipment is installed and commissioned as per requirements of Section 01 91 13 and manufacturers written instructions/requirements.

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 40 00.

3.3 STARTING EQUIPMENT AND SYSTEMS

A. Provide manufacturer's field representative to prepare and start equipment.

B. Adjust for proper operation within manufacturer's published tolerances.

C. Demonstrate proper operation of equipment to Owner's designated representative.

3.4 CLEANING

A. Clean the entire installation at substantial completion .

B. Protect installed equipment from subsequent construction operations.

END OF SECTION 26 05 02 260500

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SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Single conductor building wire.

B. Service entrance cable.

C. Metal-clad cable.

D. Power and control tray cable.

E. Variable-frequency drive cable.

F. Photovoltaic wire.

G. Wiring connectors.

H. Electrical tape.

I. Heat shrink tubing.

J. Oxide inhibiting compound.

K. Wire pulling lubricant.

L. Cable ties.

M. Firestop sleeves.

1.2 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 260526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.

C. Section 262100 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conductors.

D. Section 263100 - Photovoltaic Collectors: Additional wiring requirements for photovoltaic systems.

1.3 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire 2013 (Reapproved 2018).

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft 2011 (Reapproved 2017).

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes 2010, with Editorial Revision (2020).

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation 2004 (Reapproved 2020).

E. ASTM B800 - Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes - Annealed and Intermediate Tempers 2005 (Reapproved 2021).

F. ASTM B801 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation 2018.

G. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape 2017.

H. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes 2020.

I. FS A-A-59544 - Cable and Wire, Electrical (Power, Fixed Installation) 2008a (Validated 2019).

J. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

K. NECA 104 - Standard for Installing Aluminum Building Wire and Cable 2012.

L. NECA 120 - Standard for Installing Armored Cable (AC) and Type Metal-Clad (MC) Cable 2018.

M. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy 2021.

N. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.

O. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

P. NFPA 79 - Electrical Standard for Industrial Machinery 2021.

Q. UL 44 - Thermoset-Insulated Wires and Cables Current Edition, Including All Revisions.

R. UL 83 - Thermoplastic-Insulated Wires and Cables Current Edition, Including All Revisions.

S. UL 267 - Outline of Investigation for Wire-Pulling Compounds Most Recent Edition, Including All Revisions.

T. UL 486A-486B - Wire Connectors Current Edition, Including All Revisions.

U. UL 486C - Splicing Wire Connectors Current Edition, Including All Revisions.

V. UL 486D - Sealed Wire Connector Systems Current Edition, Including All Revisions.

W. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape Current Edition, Including All Revisions.

X. UL 854 - Service-Entrance Cables Current Edition, Including All Revisions.

Y. UL 1277 - Electrical Power and Control Tray Cables with Optional Optical-Fiber Members Current Edition, Including All Revisions.

Z. UL 1569 - Metal-Clad Cables Current Edition, Including All Revisions.

AA. UL 2277 - Outline of Investigation for Flexible Motor Supply Cable and Wind Turbine Tray Cable Current Edition, Including All Revisions.

BB. UL 4703 - Standard for Photovoltaic Wire Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
   3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

C. Sustainable Design Documentation: Submit manufacturer's product data on conductor and cable showing compliance with specified lead content requirements.

D. Manufactured Wiring System Shop Drawings: Provide plan views indicating proposed system layout with components identified; indicate branch circuit connections.

E. Wire Pulling Lubricant: Certification of compatibility with conductors/cables where used with the following insulation/jacket types:
   1. Low-smoke zero halogen (LSZH).

F. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.

G. Field Quality Control Test Reports.

H. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

I. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Engineer and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

C. Nonmetallic-sheathed cable is not permitted.

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Provide new conductors and cables manufactured not more than one year prior to installation.

D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

E. Comply with NEMA WC 70.

F. Comply with FS A-A-59544 where applicable.

G. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

H. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

I. Conductors for Grounding and Bonding: Also comply with Section 260526.

J. Conductors and Cables Installed in Cable Tray: Listed and labeled as suitable for cable tray use.

K. Conductors and Cables Installed Where Exposed to Direct Rays of Sun: Listed and labeled as sunlight resistant.

L. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.

M. Conductor Material:

1. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
2. Tinned Copper Conductors: Comply with ASTM B33.
3. Aluminum Conductors (only where specifically indicated or permitted for substitution): AA-8000 series aluminum alloy conductors recognized by ASTM B800 and compact stranded in accordance with ASTM B801 unless otherwise indicated.

N. Minimum Conductor Size:
1. Branch Circuits: 12 AWG.
a. Exceptions:
2. Control Circuits: 14 AWG.

O. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

P. Conductor Color Coding:
1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
3. Color Code:
a. 208Y/120 V, 3 Phase, 4 Wire System:
1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.
4) Neutral/Grounded: White.
b. Equipment Ground, All Systems: Green.
c. For control circuits, comply with manufacturer's recommended color code.

2.3 SINGLE CONDUCTOR BUILDING WIRE

A. Manufacturers:
1. Copper Building Wire:
a. Cerro Wire LLC: www.cerrowire.com/#sle.
b. Encore Wire Corporation: www.encorewire.com/#sle.
c. General Cable Technologies Corporation: www.generalcable.com/#sle.
d. Southwire Company: www.southwire.com/#sle.
e. Substitutions: See Section 016000 - Product Requirements.
2. Aluminum Building Wire (only where specifically indicated or permitted for substitution):
a. Encore Wire Corporation: www.encorewire.com/#sle.
b. Southwire Company: www.southwire.com/#sle.
c. Stabiloy, a brand of General Cable Technologies Corporation: www.stabiloy.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.

B. Description: Single conductor insulated wire.

C. Conductor Stranding:
   1. Feeders and Branch Circuits:
      a. Size 10 AWG and Smaller: Solid.
      b. Size 8 AWG and Larger: Stranded.
   2. Control Circuits: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation:
   1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
      a. Size 4 AWG and Larger: Type XHHW-2.
      b. Installed Underground: Type XHHW-2.
      c. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.

2.4 SERVICE ENTRANCE CABLE

A. Manufacturers:
   1. Copper Service Entrance Cable:
      a. Cerro Wire LLC: www.cerrowire.com/#sle.
      b. Encore Wire Corporation: www.encorewire.com/#sle.
      c. Southwire Company: www.southwire.com/#sle.
      d. Substitutions: See Section 016000 - Product Requirements.

B. Service Entrance Cable for Underground Use: NFPA 70, Type USE single-conductor cable listed and labeled as complying with UL 854, Type USE-2, and with UL 44 Type RHH/RHW-2.

C. Conductor Stranding: Stranded.

D. Insulation Voltage Rating: 600 V.

2.5 METAL-CLAD CABLE

A. Manufacturers:
   1. AFC Cable Systems Inc: www.afcweb.com/#sle.
   2. Encore Wire Corporation: www.encorewire.com/#sle.
   3. Southwire Company: www.southwire.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

C. Conductor Stranding:
   1. Size 10 AWG and Smaller: Solid.
   2. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.

F. Provide dedicated neutral conductor for each phase conductor where indicated or required.

G. Grounding: Full-size integral equipment grounding conductor.
   1. Provide additional isolated/insulated grounding conductor where indicated or required.

H. Armor: Steel, interlocked tape.

2.6 POWER AND CONTROL TRAY CABLE

A. Manufacturers:
   1. Encore Wire Corporation: www.encorewire.com/#sle.
   2. General Cable Technologies Corporation: www.generalcable.com/#sle.
   3. Okonite: www.okonite.com/#sle.
   4. Southwire Company: www.southwire.com/#sle.
   5. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type TC cable listed and labeled as complying with UL 1277.

C. Conductor Stranding: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation: Type XHHW or XHHW-2.

F. Jacket: PVC or Chlorinated Polyethylene (CPE).

2.7 VARIABLE-FREQUENCY DRIVE CABLE

A. Manufacturers:
   1. Service Wire Co; ServiceDrive: www.servicewire.com/#sle.

B. Description: Flexible motor supply cable listed and labeled as complying with UL 2277 in accordance with NFPA 79; specifically designed for use with variable frequency drives and associated nonlinear power distortions.

C. Conductor Stranding: Stranded.

D. Insulation Voltage Rating: 1000 V.

E. Insulation: Use only thermoset insulation types; thermoplastic insulation types are not permitted.

F. Grounding: Full-size integral equipment grounding conductor or symmetrical arrangement of multiple conductors of equivalent size.

G. Provide metallic shielding.

H. Jacket: PVC or Chlorinated Polyethylene (CPE).

2.8 PHOTOVOLTAIC WIRE

A. Manufacturers:
1. Service Wire Co; ServiceSolar: www.servicewire.com/#sle.

B. Description: Sunlight-resistant, single-conductor, insulated photovoltaic wire listed and labeled as complying with UL 4703; specifically designed for interconnection wiring of photovoltaic power systems in accordance with NFPA 70.

C. Conductor Stranding: Stranded.

D. Insulation Voltage Rating: As required for photovoltaic power system voltage.

2.9 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Wiring Connectors for Splices and Taps:
1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
3. Connectors for Aluminum Conductors: Use compression connectors.

C. Wiring Connectors for Terminations:
1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.

6. Aluminum Conductors: Use compression connectors for all connections.
7. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
8. Conductors for Control Circuits: Use crimped terminals for all connections.

D. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

E. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

F. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
1. Manufacturers:
a. 3M: www.3m.com/#sle.
b. Ideal Industries, Inc: www.idealindustries.com/#sle.
c. NSI Industries LLC: www.nsiindustries.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.

G. Mechanical Connectors: Provide bolted type or set-screw type.
1. Manufacturers:
a. Burndy LLC: www.burndy.com/#sle.
b. Ilsco: www.ilsco.com/#sle.
c. Thomas & Betts Corporation: www.tnb.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.

H. Compression Connectors: Provide circumferential type or hex type crimp configuration.
1. Manufacturers:
a. Burndy LLC: www.burndy.com/#sle.
b. Ilsco: www.ilsco.com/#sle.
c. Thomas & Betts Corporation: www.tnb.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.

I. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
1. Manufacturers:
a. Burndy LLC: www.burndy.com/#sle.
b. Ilsco: www.ilsco.com/#sle.
c. Thomas & Betts Corporation: www.tnb.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.

2.10 ACCESSORIES

A. Electrical Tape:
1. Manufacturers:
a. 3M: www.3m.com/#sle.
b. Plymouth Rubber Europa: www.plymouthrubber.com/#sle.

c. Substitutions: See Section 016000 - Product Requirements.

2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
6. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
7. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
1. Manufacturers:
a. 3M: www.3m.com/#sle.
b. Burndy LLC: www.burndy.com/#sle.
c. Thomas & Betts Corporation: www.tnb.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.

C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
1. Manufacturers:
a. Burndy LLC: www.burndy.com/#sle.
b. Ideal Industries, Inc: www.idealindustries.com/#sle.
c. Ilsco: www.ilsco.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.

D. Wire Pulling Lubricant:
1. Manufacturers:
a. 3M: www.3m.com/#sle.
b. American Polywater Corporation: www.polywater.com/#sle.
c. Ideal Industries, Inc: www.idealindustries.com/#sle.
2. Listed and labeled as complying with UL 267.
3. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
4. Suitable for use at installation temperature.
5. Products:

a. American Polywater Corporation; Polywater J Cable Pulling Lubricant: www.polywater.com/#sle.
b. American Polywater Corporation; Polywater LZ Cable Pulling Lubricant: www.polywater.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.

E. Cable Ties: Material and tensile strength rating suitable for application.
1. Manufacturers:
a. Burndy LLC: www.burndy.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

F. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for cables and roofing system to be installed; designed to accommodate existing penetrations where applicable.
1. Products:
a. Menzies Metal Products; Electrical Roof Stack and Cap: www.menzies-metal.com/#sle.
b. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.

G. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
1. Products:
a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

H. Fire-Protective Coating for Electrical Conductors and Cables: Field-applied, intumescent or ablative coating designed to prevent ignition and propagation of fire along thermoplastic-insulated conductors and cables.
1. Products:
a. Vimasco Corporation; CharCoat CC Cable Coating: www.charcoat.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

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

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as indicated.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

A. Circuiting Requirements:
   1. Unless dimensioned, circuit routing indicated is diagrammatic.
   2. When circuit destination is indicated without specific routing, determine exact routing required.
   3. Arrange circuiting to minimize splices.
   4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
   5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
   6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
   7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
   8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
   9. Provide oversized neutral/grounded conductors where indicated and as specified below.
      a. Provide 200 percent rated neutral for feeders fed from K-rated transformers.
      b. Provide 200 percent rated neutral for feeders serving panelboards with 200 percent rated neutral bus.

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

C. Perform work in accordance with NECA 1 (general workmanship).

D. Install aluminum conductors in accordance with NECA 104.

E. Install metal-clad cable (Type MC) in accordance with NECA 120.

F. Installation in Raceway:
   1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
   2. Pull all conductors and cables together into raceway at same time.
   3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.

4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.

I. Terminate cables using suitable fittings.
1. Metal-Clad Cable (Type MC):
   a. Use listed fittings.
   b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

J. Variable-Frequency Drive Cable: Terminate shielding at both variable-frequency motor controller and associated motor using glands or termination kits recommended by manufacturer.

K. Install conductors with a minimum of 12 inches of slack at each outlet.

L. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.

M. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

N. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

O. Make wiring connections using specified wiring connectors.
1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.
4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
5. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.
6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.

7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

P. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
   1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
      b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
   2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
      b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
   3. Wet Locations: Use heat shrink tubing.

Q. Insulate ends of spare conductors using vinyl insulating electrical tape.

R. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

S. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.4 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
   1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION 260519

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SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground bars.

E. Ground rod electrodes.

F. Ground plate electrodes.

G. Ground enhancement material.

H. Ground access wells.

1.2 RELATED REQUIREMENTS

A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
   1. Includes oxide inhibiting compound.

B. Section 260536 - Cable Trays for Electrical Systems: Additional grounding and bonding requirements for cable tray systems.

C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 263100 - Photovoltaic Collectors: Additional grounding and bonding requirements for photovoltaic systems.

1.3 REFERENCE STANDARDS

A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System 2012.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings 2017.

D. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.

E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 467 - Grounding and Bonding Equipment Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Verify exact locations of underground metal water service pipe entrances to building.
2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

C. Shop Drawings:

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Field quality control test reports.

F. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.

B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

D. Grounding System Resistance:
1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Engineer. Precipitation within the previous 48 hours does not constitute normally dry conditions.
2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

E. Grounding Electrode System:
1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
    a. Provide continuous grounding electrode conductors without splice or joint.
    b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
2. Metal Underground Water Pipe(s):
    a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
    b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.

c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.

3. Metal In-Ground Support Structure:
   a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
4. Concrete-Encased Electrode:
   a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
5. Ground Ring:
   a. Provide a ground ring encircling the building or structure consisting of bare copper conductor not less than 2 AWG in direct contact with earth, installed at a depth of not less than 30 inches.
   b. Where location is not indicated, locate ground ring conductor at least 24 inches outside building perimeter foundation.
   c. Provide ground enhancement material around conductor where indicated.
   d. Provide connection from ground ring conductor to:
      1) Perimeter columns of metal building frame.
      2) Ground rod electrodes located as indicated.
6. Ground Rod Electrode(s):
   a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
   b. Space electrodes not less than 10 feet from each other and any other ground electrode.
   c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
   d. Provide ground enhancement material around electrode where indicated.
   e. Provide ground access well for each electrode.
7. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
8. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
   a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
   b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
   c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
9. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in NFPA 70.

F. Service-Supplied System Grounding:

1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

G. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
    a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
    b. Metal gas piping.
    c. Metal process piping.
8. Provide bonding for interior metal air ducts.
9. Provide bonding for metal building frame.
10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.

H. Isolated Ground System:
1. Where isolated ground receptacles or other isolated ground connections are indicated, provide separate isolated/insulated equipment grounding conductors.
2. Connect isolated/insulated equipment grounding conductors only to separate isolated/insulated equipment ground busses.
3. Connect the isolated/insulated equipment grounding conductors to the solidly bonded equipment ground bus only at the service disconnect or separately derived system disconnect. Do not make any other connections between isolated ground system and normal equipment ground system on the load side of this connection.

I. Communications Systems Grounding and Bonding:

1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
   a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
   b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
   c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
   d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
   1. Provide products listed, classified, and labeled as suitable for the purpose intended.
   2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 260526:
   1. Use insulated copper conductors unless otherwise indicated.
      a. Exceptions:
         1) Use bare copper conductors where installed underground in direct contact with earth.

         2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:
   1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
   2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
   3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
   4. Manufacturers - Mechanical and Compression Connectors:
      a. allG Fabrication: www.allgfab.com/#sle.
      b. Burndy LLC: www.burndy.com/#sle.
      c. Harger Lightning & Grounding: www.harger.com/#sle.
      d. nVent ERICO: www.nvent.com/#sle.
      e. Thomas & Betts Corporation: www.tnb.com/#sle.
      f. Substitutions: See Section 016000 - Product Requirements.
   5. Manufacturers - Exothermic Welded Connections:
      a. Burndy LLC: www.burndy.com/#sle.
      b. nVent ERICO; Cadweld: www.nvent.com/#sle.
      c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.
      d. Substitutions: See Section 016000 - Product Requirements.

D. Ground Bars:

1. Description: Copper rectangular ground bars with mounting brackets and insulators.
2. Size: As indicated.
3. Holes for Connections: As indicated or as required for connections to be made.
4. Manufacturers:
    a. allG Fabrication: www.allgfab.com/#sle.
    b. Harger Lightning & Grounding: www.harger.com/#sle.
    c. nVent ERICO: www.nvent.com/#sle.
    d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.

E. Ground Rod Electrodes:
1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
4. Where rod lengths of greater than 10 feet are indicated or otherwise required, sectionalized ground rods may be used.
5. Manufacturers:
    a. allG Fabrication: www.allgfab.com/#sle.
    b. Galvan Industries, Inc: www.galvanelectrical.com/#sle.
    c. Harger Lightning & Grounding: www.harger.com/#sle.
    d. nVent ERICO: www.nvent.com/#sle.
    e. Substitutions: See Section 016000 - Product Requirements.

F. Ground Plate Electrodes:
1. Material: Copper.
2. Size: 24 by 24 by 1/4 inches, unless otherwise indicated.
3. Manufacturers:
    a. allG Fabrication: www.allgfab.com/#sle.
    b. Harger Lightning & Grounding: www.harger.com/#sle.
    c. nVent ERICO: www.nvent.com/#sle.
    d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.
    e. Substitutions: See Section 016000 - Product Requirements.

G. Ground Enhancement Material:
1. Description: Factory-mixed conductive material designed for permanent and maintenance-free improvement of grounding effectiveness by lowering resistivity.
2. Resistivity: Not more than 20 ohm-cm in final installed form.
3. Manufacturers:
    a. Harger Lightning & Grounding: www.harger.com/#sle.
    b. nVent ERICO; GEM: www.nvent.com/#sle.
    c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.
    d. Substitutions: See Section 016000 - Product Requirements.

H. Ground Access Wells:

1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
   a. Round Wells: Not less than 8 inches in diameter.
   b. Rectangular Wells: Not less than 12 by 12 inches.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
4. Cover: Factory-identified by permanent means with word "GROUND".
5. Manufacturers:
   a. Harger Lightning & Grounding: www.harger.com/#sle.
   b. nVent ERICO: www.nvent.com/#sle.
   c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.
   d. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as indicated.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Perform work in accordance with NECA 1 (general workmanship).

C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
   1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
   2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.

D. Ground Plate Electrodes: Unless otherwise indicated, install ground plate electrodes at a depth of not less than 30 inches.

E. Make grounding and bonding connections using specified connectors.

1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

F. Identify grounding and bonding system components in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.13.

D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 055000 - Metal Fabrications: Materials and requirements for fabricated metal supports.

C. Section 260548 - Vibration and Seismic Controls for Electrical Systems.

1.3 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2019.

D. MFMA-4 - Metal Framing Standards Publication 2004.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

F. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. UL 5B - Strut-Type Channel Raceways and Fittings Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
   2. Coordinate work to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
   4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.

5. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 033000.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.

C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

D. Evaluation Reports: For products specified as requiring evaluation and recognition by ICC Evaluation Service, LLC (ICC-ES), provide current ICC-ES evaluation reports upon request.

E. Installer's qualification statement.

F. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

A. Maintain at project site one copy of each referenced document that prescribes execution requirements.

B. Installer Qualifications for Powder-Actuated Fasteners: Certified by fastener system manufacturer with current operator's license.

C. Installer Qualifications for Field Welding: See Section 055000.

D. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Comply with the following. Where requirements differ, comply with most stringent.
      a. NFPA 70.
      b. Applicable building code.
      c. Requirements of authorities having jurisdiction.
   2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.
   3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
   4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
   5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   6. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
   7. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
      a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
      c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Components for Vibration Isolation and/or Seismic Controls: See Section 260548.

C. Materials for Metal Fabricated Supports: See Section 055000.

D. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
   1. Manufacturers:
      a. ABB: www.electrification.us.abb.com/#sle.
      b. Eaton Corporation: www.eaton.com/#sle.
      c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
      d. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
      e. nVent; Caddy: www.nvent.com/#sle.
      f. Substitutions: See Section 016000 - Product Requirements.
   2. Conduit Straps: One-hole or two-hole type; steel or malleable iron.

3. Conduit Clamps: Bolted type unless otherwise indicated.
4. Products:
   a. Gripple, Inc; Universal Bracket: www.gripple.com/#sle.
   b. Gripple, Inc; Fast Trak: www.gripple.com/#sle.
   c. Gripple, Inc; Universal Clamp (Threaded): www.gripple.com/#sle.
   d. Gripple, Inc; Low Profile Bracket Kits: www.gripple.com/#sle.
   e. Substitutions: See Section 016000 - Product Requirements.

E. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
1. Manufacturers:
   a. ABB: www.electrification.us.abb.com/#sle.
   b. Eaton Corporation: www.eaton.com/#sle.
   c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
   d. nVent; Caddy: www.nvent.com/#sle.

F. Metal Channel/Strut Framing Systems:
1. Manufacturers:
   a. ABB: www.electrification.us.abb.com/#sle.
   b. Atkore International Inc; Unistrut: www.unistrut.us/#sle.
   c. Custom Strut and Roll Forming, LLC: www.customstrut.com/#sle.
   d. Eaton Corporation: www.eaton.com/#sle.
   e. Elgen Manufacturing Company, Inc: www.elgenmfg.com/#sle.
   f. Substitutions: See Section 016000 - Product Requirements.
   g. Source Limitations: Furnish channel/strut and associated fittings, accessories, and hardware produced by single manufacturer.
2. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
3. Comply with MFMA-4.
4. Channel/Strut Used as Raceway, Where Indicated: Listed and labeled as complying with UL 5B.
5. Channel Material:
   a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
   b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
6. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
7. Minimum Channel Dimensions: 1-5/8 inch wide by 13/16 inch high.

G. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
1. Minimum Size, Unless Otherwise Indicated or Required:
   a. Equipment Supports: 1/2-inch diameter.
   b. Busway Supports: 1/2-inch diameter.
   c. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch diameter.
   d. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch diameter.
   e. Trapeze Support for Multiple Conduits: 3/8-inch diameter.
   f. Outlet Boxes: 1/4-inch diameter.
   g. Luminaires: 1/4-inch diameter.

H. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
1. Manufacturers:
   a. Atkore International Inc; Unistrut: www.unistrut.us/#sle.
   b. Eaton Corporation: www.eaton.com/#sle.
   c. nVent; Caddy: www.nvent.com/#sle.
   d. PHP Systems/Design: www.phpsd.com/#sle.
2. Description: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring attachment to roof structure and not penetrating roofing assembly, with support fixtures as specified.
3. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
4. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
5. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

I. Anchors and Fasteners:
1. Manufacturers - Mechanical Anchors:
   a. Dewalt: anchors.dewalt.com/#sle.
   b. Hilti, Inc: www.hilti.com/#sle.
   c. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
   d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
   e. [_____].
   f. Substitutions: See Section 016000 - Product Requirements.
2. Manufacturers - Powder-Actuated Fastening Systems:
   a. Dewalt: anchors.dewalt.com/#sle.
   b. Hilti, Inc: www.hilti.com/#sle.
   c. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com/#sle.
   d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
   e. Substitutions: See Section 016000 - Product Requirements.
3. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
4. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
6. Hollow Masonry: Use toggle bolts.
7. Hollow Stud Walls: Use toggle bolts.
8. Steel: Use beam clamps, machine bolts, or welded threaded studs.
9. Sheet Metal: Use sheet metal screws.
10. Wood: Use wood screws.
11. Plastic and lead anchors are not permitted.
12. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
    a. Manufacturer: Same as manufacturer of metal channel/strut framing system.
    b. Comply with MFMA-4.
    c. Channel Material: Use galvanized steel.

d. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.

13. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install hangers and supports in accordance with NECA 1.

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

E. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.

G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Provide required vibration isolation and/or seismic controls; see Section 260548.

I. Field Welding, Where Approved by Engineer: See Section 055000.

J. Equipment Support and Attachment:
1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.

4. Unless otherwise indicated, mount floor-mounted equipment on properly sized concrete pad 4 inches in height; see Section 033000.
5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

K. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

L. Secure fasteners in accordance with manufacturer's recommended torque settings.

M. Remove temporary supports.

N. Identify independent electrical component support wires above accessible ceilings, where permitted, with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 260529

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SECTION 260533.13 - CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Stainless steel rigid metal conduit (RMC).

C. Aluminum rigid metal conduit (RMC).

D. Galvanized steel intermediate metal conduit (IMC).

E. Stainless steel intermediate metal conduit (IMC).

F. PVC-coated galvanized steel rigid metal conduit (RMC).

G. Flexible metal conduit (FMC).

H. Liquidtight flexible metal conduit (LFMC).

I. Galvanized steel electrical metallic tubing (EMT).

J. Stainless steel electrical metallic tubing (EMT).

K. Aluminum electrical metallic tubing (EMT).

L. Rigid polyvinyl chloride (PVC) conduit.

M. Liquidtight flexible nonmetallic conduit (LFNC).

N. Reinforced thermosetting resin conduit (RTRC).

O. High-density polyethylene (HDPE) conduit.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete encasement of conduits.

B. Section 078400 - Firestopping.

C. Section 260526 - Grounding and Bonding for Electrical Systems.

D. Section 260529 - Hangers and Supports for Electrical Systems.

E. Section 260548 - Vibration and Seismic Controls for Electrical Systems.

F. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

G. Section 312316 - Excavation.

H. Section 312323 - Fill: Bedding and backfilling.

1.3 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC) 2020.

B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S) 2020.

C. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A) 2020.

D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit 2018.

E. ASTM F2160 - Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD) 2016.

F. ASTM F2176 - Standard Specification for Mechanical Couplings Used on Polyethylene Conduit, Duct and Innerduct 2017.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

H. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT) 2020.

I. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit 2004.

J. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC) 2017.

K. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable 2014.

L. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit 2018.

M. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit 2020.

N. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing 2021.

O. NEMA TC 7 - Solid-Wall Coilable and Straight Electrical Polyethylene Conduit 2021.

P. NEMA TC 14 (SERIES) - Reinforced Thermosetting Resin Conduit and Fittings Series 2015.

Q. NEMA TC 14.AG - Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings 2015 (Reaffirmed 2021).

R. NEMA TC 14.BG - Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings 2015 (Reaffirmed 2020).

S. NEMA TC 14.XW - Extra Heavy Wall Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings 2015 (Reaffirmed 2021).

T. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

U. UL 1 - Flexible Metal Conduit Current Edition, Including All Revisions.

V. UL 6 - Electrical Rigid Metal Conduit-Steel Current Edition, Including All Revisions.

W. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel Current Edition, Including All Revisions.

X. UL 360 - Liquid-Tight Flexible Metal Conduit Current Edition, Including All Revisions.

Y. UL 514A - Metallic Outlet Boxes Current Edition, Including All Revisions.

Z. UL 514B - Conduit, Tubing, and Cable Fittings Current Edition, Including All Revisions.

AA. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings Current Edition, Including All Revisions.

BB. UL 651A - Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit Current Edition, Including All Revisions.

CC. UL 746C - Polymeric Materials – Use in Electrical Equipment Evaluations Current Edition, Including All Revisions.

DD. UL 797 - Electrical Metallic Tubing-Steel Current Edition, Including All Revisions.

EE. UL 797A - Electrical Metallic Tubing - Aluminum and Stainless Steel Current Edition, Including All Revisions.

FF. UL 1242 - Electrical Intermediate Metal Conduit-Steel Current Edition, Including All Revisions.

GG. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit Current Edition, Including All Revisions.

HH. UL 2419 - Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds Current Edition, Including All Revisions.

II. UL 2420 - Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings Current Edition, Including All Revisions.

JJ. UL 2515 - Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings Current Edition, Including All Revisions.

KK. UL 2515A - Standard for Supplemental Requirements for Extra Heavy Wall Reinforced Thermosetting Resin Conduit (RTRC) and Fittings Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
5. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

C. Shop Drawings:
1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
2. Include proposed locations of roof penetrations and proposed methods for sealing.

D. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2-inch (53 mm) trade size and larger.

1.6 QUALITY ASSURANCE

A. Documents at Project Site: Maintain at project site one copy of manufacturer's instructions and shop drawings.

B. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.

B. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:
1. Under Slab on Grade: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), galvanized steel electrical metallic tubing (EMT), stainless steel electrical metallic tubing (EMT), rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, galvanized steel electrical metallic tubing (EMT), stainless steel electrical metallic tubing (EMT), rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
3. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), galvanized steel electrical metallic tubing (EMT), stainless steel electrical metallic tubing (EMT), rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).

4. Where rigid polyvinyl chloride (PVC) conduit is provided, transition to galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), or schedule 80 rigid PVC conduit where emerging from underground.
5. Where rigid polyvinyl (PVC) conduit larger than 2-inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit (RMC) elbows, stainless steel rigid metal conduit (RMC) elbows, galvanized steel intermediate metal conduit (IMC) elbows, stainless steel intermediate metal conduit (IMC) elbows, PVC-coated galvanized steel rigid metal conduit (RMC) elbows, or concrete-encased PVC elbows for bends.
6. Where galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC) is installed in direct contact with earth where soil has resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection.
7. Where galvanized steel electrical metallic tubing (EMT) is installed in direct contact with earth, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection.
8. Where aluminum rigid metal conduit (RMC) or aluminum electrical metallic tubing (EMT) is installed in direct contact with earth, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection.
9. Where galvanized rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or galvanized steel electrical metallic tubing (EMT) emerges from concrete into soil, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection for minimum of 4 inches on either side of where conduit emerges.

D. Embedded Within Concrete:
1. Within Slab on Grade: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), galvanized steel electrical metallic tubing (EMT), rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC). Embed within structural slabs only where approved by Structural Engineer.
2. Within Slab Above Ground: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), galvanized steel electrical metallic tubing (EMT), rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC). Embed within structural slabs only where approved by Structural Engineer.

3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), galvanized steel electrical metallic tubing (EMT), rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), or galvanized steel electrical metallic tubing (EMT) where emerging from concrete.
5. Where galvanized steel electrical metallic tubing (EMT) emerges from concrete into salt air, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection for minimum of 4 inches on either side of where conduit emerges.

E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).
1. Locations subject to physical damage include, but are not limited to:
    a. Where exposed below 8 feet, except within electrical and communication rooms or closets.

K. Exposed, Interior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or stainless steel intermediate metal conduit (IMC).

L. Exposed, Exterior, Not Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

M. Exposed, Exterior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or stainless steel intermediate metal conduit (IMC).
   1. Exterior locations subject to severe physical damage include, but are not limited to:
      a. Where exposed to vehicular traffic below 20 feet.

N. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

O. Corrosive Locations Above Ground: Use stainless steel rigid metal conduit (RMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), stainless steel electrical metallic tubing (EMT), or reinforced thermosetting resin conduit (RTRC).

P. Flexible Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit (FMC).
   1. Maximum Length: 6 feet.

Q. Flexible Connections to Vibrating Equipment:
   1. Dry Locations: Use flexible metal conduit (FMC).
   2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit (LFMC).
   3. Maximum Length: 6 feet unless otherwise indicated.
   4. Vibrating equipment includes, but is not limited to:
      a. Transformers.
      b. Motors.

2.2 CONDUIT - GENERAL REQUIREMENTS

A. Comply with NFPA 70.

B. Provide conduit, fittings, supports, and accessories required for complete raceway system.

C. Provide products listed, classified, and labeled as suitable for purpose intended.

D. Minimum Conduit Size, Unless Otherwise Indicated:

1. Branch Circuits: 3/4-inch trade size.
2. Branch Circuit Homeruns: 3/4-inch trade size.
3. Control Circuits: 1/2-inch trade size.
4. Flexible Connections to Luminaires: 3/8-inch trade size.
5. Underground, Interior: 3/4-inch trade size.
6. Underground, Exterior: 1-inch trade size.

E. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:
1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
2. Nucor Tubular Products: www.nucortubular.com/#sle.
3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:
1. Manufacturers:
   a. ABB; T&B: www.electrification.us.abb.com/#sle.
   b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
   c. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
   d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
3. Material: Use steel or malleable iron.
4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.4 STAINLESS STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:
1. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
2. Gibson Stainless & Specialty Inc: www.gibsonstainless.com/#sle.
3. Patriot Industries, a division of Patriot Aluminum Products LLC: www.patriotsas.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type RMC stainless steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6A.

C. Fittings:

1. Manufacturers:
   a. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
   b. Eaton: www.eaton.com/#sle.
   c. Gibson Stainless & Specialty Inc: www.gibsonstainless.com/#sle.
   d. Patriot Industries, a division of Patriot Aluminum Products LLC: www.patriotsas.com/#sle.
2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A.
3. Material: Use stainless steel with corrosion resistance equivalent to conduit.
4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.5 ALUMINUM RIGID METAL CONDUIT (RMC)

A. Manufacturers:
   1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
   2. Nucor Tubular Products: www.nucortubular.com/#sle.
   3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
   4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
   5. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.

C. Fittings:
   1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A.
   2. Material: Use aluminum.
   3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.6 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:
   1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
   2. Nucor Tubular Products: www.nucortubular.com/#sle.
   3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
   4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.

B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

C. Fittings:
   1. Manufacturers:
      a. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
      b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
      c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.

2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
3. Material: Use steel or malleable iron.
4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.7 STAINLESS STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:
1. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

C. Fittings:
1. Manufacturers:
a. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
b. Eaton: www.eaton.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.
2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
3. Material: Use stainless steel with corrosion resistance equivalent to conduit.
4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.8 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:
1. ABB; Ocal: www.electrification.us.abb.com/#sle.
2. Calbond, a division of Atkore International www.calbond.com/#sle
3. Robroy Industries: www.robroy.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.

C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil, 0.040 inch.

D. Interior Coating: Urethane, minimum thickness of 2 mil, 0.002 inch.

E. PVC-Coated Boxes and Fittings:
1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
2. Nonhazardous Locations: Use boxes and fittings listed and labeled as complying with UL 514A, UL 514B, or UL 6.
3. Material: Use steel or malleable iron.
4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil, 0.040 inch.

F. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil, 0.015 inch.

2.9 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:
1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
2. Electri-Flex Company: www.electriflex.com/#sle.
3. International Metal Hose: www.metalhose.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.

C. Fittings:
1. Manufacturers:
a. ABB; T&B: www.electrification.us.abb.com/#sle.
b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.

2.10 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:
1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
2. Electri-Flex Company: www.electriflex.com/#sle.
3. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:
1. Manufacturers:
a. ABB; T&B: www.electrification.us.abb.com/#sle.
b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.

2.11 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
   1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
   2. Nucor Tubular Products: www.nucortubular/#sle.
   3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
   4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
   5. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Fittings:
   1. Manufacturers:
      a. ABB; T&B: www.electrification.us.abb.com/#sle.
      b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
      c. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
      d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
      e. Substitutions: See Section 016000 - Product Requirements.
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Material: Use steel or malleable iron.
   4. Connectors and Couplings: Use compression/gland or set-screw type.
      a. Do not use indenter type connectors and couplings.
   5. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.
   6. Embedded Within Concrete, Where Permitted: Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.

2.12 STAINLESS STEEL ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
   1. Calbrite, a division of Atkore International: www.calbrite.com/#sle.

B. Description: NFPA 70, Type EMT stainless steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797A.

C. Fittings:
   1. Manufacturers:
      a. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Material: Use stainless steel with corrosion resistance equivalent to conduit.
   4. Connectors and Couplings: Use compression/gland or set-screw type.
   5. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.

2.13 ALUMINUM ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
   1. American Conduit, a division of Hydro: www.americanconduit.com/#sle.
   2. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type EMT aluminum electrical metallic tubing listed and labeled as complying with UL 797A.

C. Fittings:
   1. Manufacturers:
      a. Arlington Industries: www.aifittings.com/#sle.
      b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
      c. Substitutions: See Section 016000 - Product Requirements.
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; listed for use with aluminum EMT.
   3. Material: Use aluminum.
   4. Connectors and Couplings: Use compression/gland or set-screw type.
      a. Do not use indenter type connectors and couplings.
   5. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.

2.14 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Manufacturers:
   1. ABB; Carlon: www.carlon.com/#sle.
   2. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
   3. Cantex Inc: www.cantexinc.com/#sle.
   4. Heritage Plastics, a division of Atkore International: www.heritageplastics.com/#sle.
   5. JM Eagle: www.jmeagle.com/#sle.
   6. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

C. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
   2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.15 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. Manufacturers:
   1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
   2. Electri-Flex Company: www.electriflex.com/#sle.

3. IPEX, a division of Aliaxis: www.ipexna.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.

C. Fittings:
1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for type of conduit to be connected.

2.16 REINFORCED THERMOSETTING RESIN CONDUIT (RTRC)

A. Manufacturers:
1. Champion Fiberglass, Inc: www.championfiberglass.com/#sle.
2. FRE Composites: www.frecompositesinc.com/#sle.
3. United Fiberglass of America, Inc: www.unitedfiberglass.com/#sle.
4. [_____].

B. Applications:
1. Above Ground, Not Subject to Physical Damage: Use aboveground (AG), SW (Standard Wall), HW (Heavy Wall), or XW (Extra Heavy Wall) RTRC.
2. Above Ground, Subject to Physical Damage: Use aboveground (AG), XW (Extra Heavy Wall) RTRC.
3. Underground, Direct-Buried: Use belowground (BG), DB (direct-burial) RTRC or aboveground (AG) RTRC.
4. Underground, Embedded in Concrete: Use belowground (BG), EB (encased-burial) RTRC, belowground (BG), DB (direct-burial) RTRC, or aboveground (AG) RTRC.

C. Description: NFPA 70, Type RTRC reinforced thermosetting resin conduit complying with NEMA TC 14 (SERIES).
1. Aboveground (AG) RTRC: Comply with NEMA TC 14.AG and list and label as complying with UL 2515.
2. Aboveground (AG), XW (Extra Heavy Wall) RTRC: Comply with NEMA TC 14.XW and list and label as complying with UL 2515A.
3. Belowground (BG) RTRC: Comply with NEMA TC 14.BG and list and label as complying with UL 2420.

D. Supports: As recommended by manufacturer.

E. Fittings: Same type and manufacturer as conduit to be connected.

2.17 HIGH-DENSITY POLYETHYLENE (HDPE) CONDUIT

A. Manufacturers:
1. ABB; Carlon: www.electrification.us.abb.com/#sle.
2. Blue Diamond Industries, LLC: www.bdiky.com/#sle.

3. Eastern Wire + Conduit, a division of Atkore International: www.easternwire.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type HDPE high-density polyethylene solid-wall conduit complying with ASTM F2160 and NEMA TC 7; list and label as complying with UL 651A; Schedule 40 unless otherwise indicated.

C. Joining Methods: Approved by HDPE conduit manufacturer.

D. Mechanical Fittings: Comply with ASTM F2176; list and label as complying with UL 651A.

2.18 ACCESSORIES

A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil, 0.020 inch.

B. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.

C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

D. Epoxy Adhesive for RTRC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

E. Adhesive for HDPE and RTRC Conduit:
1. Specifically designed for bonding dissimilar materials in lieu of transition fittings, including but not limited to polyethylene, fiberglass, PVC, aluminum, and steel; UL 746C recognized.
2. Approved by adhesive manufacturer for use with materials to be joined.

F. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.

G. Foam Conduit Sealant:
1. Removable, two-part, closed-cell foam, specifically designed for sealing conduit openings against water, moisture, gases, and dust.
2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
3. Rated to hold minimum of 10 ft water head pressure.
4. Products:
   a. American Polywater Corporation; Polywater AFT Foam Duct Sealant: www.polywater.com/#sle.
   b. American Polywater Corporation; Polywater FST Foam Duct Sealant: www.polywater.com/#sle.
   c. Substitutions: See Section 016000 - Product Requirements.

H. Conduit Mechanical Seals:
1. Listed as complying with UL 514B.

2. Specifically designed for sealing conduit openings against water, moisture, gases, and dust.
3. Suitable for sealing around conductors/cables to be installed.
4. Products:
   a. American Polywater Corporation; PHRD SG Mechanical Seals: www.polywater-haufftechnik.com/#sle.
   b. Substitutions: See Section 016000 - Product Requirements.

I. Sealing Compound for Hazardous/Classified Location Sealing Fittings: Listed for use with particular fittings to be installed.

J. Sealing Systems for Concrete Penetrations:
1. Sleeves: Provide water stop ring or cement coating that bonds to concrete to prevent water infiltration.
2. Rate for minimum of 40 psig; suitable for sealing around conduits to be installed.
3. Products:
   a. American Polywater Corporation; PZVR Cement-Coated Concrete Wall Sleeves: www.polywater-haufftechnik.com/#sle.
   b. American Polywater Corporation; PHSD Mechanical Seals: www.polywater-haufftechnik.com/#sle.
   c. American Polywater Corporation; PHSI 150 Varia Double Wall Inserts: www.polywater-haufftechnik.com/#sle.
   d. Substitutions: See Section 016000 - Product Requirements.

K. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.
1. Products:
   a. Menzies Metal Products; Electrical Roof Stack and Cap: www.menzies-metal.com/#sle.
   b. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.
   c. Substitutions: See Section 016000 - Product Requirements.

L. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.
1. Products:
   a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.
   b. Substitutions: See Section 016000 - Product Requirements.

M. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
1. Products:
   a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.

b. Substitutions: See Section 016000 - Product Requirements.

N. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for conduit/duct arrangement to be installed.
1. Products:
a. Advance Products & Systems, LLC; Duct Bank Spacers: www.apsonline.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

O. Bore Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for installation within casing; furnished with roller wheels to facilitate installation, openings to facilitate grout flow, and holes for stabilization cable; suitable for casing and conduit/duct arrangement to be installed.
1. Products:
a. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install conduit in accordance with NECA 1.

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.

E. Install intermediate metal conduit (IMC) in accordance with NECA 101.

F. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by manufacturer.

G. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

H. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.

I. Conduit Routing:
1. Unless dimensioned, conduit routing indicated is diagrammatic.

2. When conduit destination is indicated without specific routing, determine exact routing required.
3. Conceal conduits unless specifically indicated to be exposed.
4. Conduits in the following areas may be exposed, unless otherwise indicated:
   a. Electrical rooms.
   b. Mechanical equipment rooms.
5. Unless otherwise approved, do not route exposed conduits:
   a. Across floors.
   b. Across roofs.
   c. Across top of parapet walls.
   d. Across building exterior surfaces.
6. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
7. Arrange conduit to maintain adequate headroom, clearances, and access.
8. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
9. Arrange conduit to provide no more than 150 feet between pull points.
10. Route conduits above water and drain piping where possible.
11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
    a. Heaters.
    b. Hot water piping.
    c. Flues.
14. Group parallel conduits in same area on common rack.

J. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 260529.
2. Provide required vibration isolation and/or seismic controls; see Section 260548.
3. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
4. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
5. Use conduit strap to support single surface-mounted conduit.
   a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
6. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
7. Use conduit clamp to support single conduit from beam clamp or threaded rod.
8. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.

9. Use nonpenetrating rooftop supports to support conduits routed across rooftops, where approved.
10. Use of spring steel conduit clips for support of conduits is not permitted.
11. Use of wire for support of conduits is not permitted.
12. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with most stringent requirements.

K. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
7. Secure joints and connections to provide mechanical strength and electrical continuity.

L. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Provide suitable sealing system where conduits penetrate exterior wall below grade.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
8. Provide metal escutcheon plates for conduit penetrations exposed to public view.
9. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 078400.

M. Underground Installation:
1. Provide trenching and backfilling; see Section 312316 and Section 312323.
2. Minimum Cover, Unless Otherwise Indicated or Required:
   a. Underground, Exterior: 18 inches.
   b. Under Slab on Grade: 12 inches to bottom of slab.
3. Provide underground warning tape along entire conduit length for service entrance where not concrete-encased; see Section 260553.

N. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
   1. Maximum Conduit Size: 1-inch trade size unless otherwise approved.
   2. Install conduits within middle one third of slab thickness.
   3. Secure conduits to prevent floating or movement during pouring of concrete.

O. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide minimum concrete cover of 3 inches on all sides unless otherwise indicated; see Section 033000.

P. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
   1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
   2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
   3. Where calculated in accordance with NFPA 70 for reinforced thermosetting resin conduit (RTRC) conduit installed above ground to compensate for thermal expansion and contraction.
   4. Where conduits are subject to earth movement by settlement or frost.

Q. Conduit Sealing:
   1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
      a. Where conduits enter building from outside.
      b. Where service conduits enter building from underground distribution system.
      c. Where conduits enter building from underground.
      d. Where conduits may transport moisture to contact live parts.
   2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
      a. Where conduits pass from outdoors into conditioned interior spaces.
      b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

R. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

S. Provide grounding and bonding; see Section 260526.

T. Identify conduits; see Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.

D. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.5 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 260533.13

SECTION 260533.16 - BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

C. Boxes and enclosures for integrated power, data, and audio/video.

D. Floor boxes.

E. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete.

B. Section 078400 - Firestopping.

C. Section 083100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.

D. Section 260529 - Hangers and Supports for Electrical Systems.

E. Section 260533.13 - Conduit for Electrical Systems:
   1. Conduit bodies and other fittings.
   2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.

F. Section 260548 - Vibration and Seismic Controls for Electrical Systems.

G. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

H. Section 262726 - Wiring Devices:
   1. Wall plates.
   2. Floor box service fittings.
   3. Poke-through assemblies.
   4. Access floor boxes.
   5. Additional requirements for locating boxes for wiring devices.

I. Section 271000 - Structured Cabling: Additional requirements for communications systems outlet boxes.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2016.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable 2014.

E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports 2013 (Reaffirmed 2020).

F. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports 2013 (Reaffirmed 2020).

G. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.

I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.

J. UL 508A - Industrial Control Panels Current Edition, Including All Revisions.

K. UL 514A - Metallic Outlet Boxes Current Edition, Including All Revisions.

L. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
   4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
   5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.

6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.

C. Samples:
1. Floor Boxes: Provide one sample(s) of each floor box proposed for substitution upon request.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 016000 - Product Requirements, for additional provisions.
2. Keys for Lockable Enclosures: Two of each different key.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 BOXES

A. General Requirements:
1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
4. Use cast aluminum boxes where aluminum rigid metal conduit is used.
5. Use suitable concrete type boxes where flush-mounted in concrete.
6. Use suitable masonry type boxes where flush-mounted in masonry walls.
7. Use raised covers suitable for the type of wall construction and device configuration where required.
8. Use shallow boxes where required by the type of wall construction.
9. Do not use "through-wall" boxes designed for access from both sides of wall.
10. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
11. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
12. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
13. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
14. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
15. Minimum Box Size, Unless Otherwise Indicated:
    a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
    b. Communications Systems Outlets: Comply with Section 271000.

c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.

16. Wall Plates: Comply with Section 262726.
17. Manufacturers:
    a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
    b. Hubbell Incorporated; Bell Products: www.hubbell-rtb.com/#sle.
    c. Hubbell Incorporated; RACO Products: www.hubbell-rtb.com/#sle.
    d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
    e. Thomas & Betts Corporation: www.tnb.com/#sle.
    f. Substitutions: See Section 016000 - Product Requirements.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
    a. Indoor Clean, Dry Locations: Type 1, painted steel.
3. Junction and Pull Boxes Larger Than 100 cubic inches:
    a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
    b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
    a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
    b. Back Panels: Painted steel, removable.
    c. Terminal Blocks: Provide voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.
5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
6. Manufacturers:
    a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
    b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com/#sle.
    c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com/#sle.
    d. Substitutions: See Section 016000 - Product Requirements.

D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may be used.
1. Manufacturers:
    a. Hubbell Incorporated: www.hubbell.com/#sle.
    b. Substitutions: See Section 016000 - Product Requirements.

E. Floor Boxes:
1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 262726; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
2. Use cast iron or nonmetallic floor boxes within slab on grade.

3. Use sheet-steel, cast iron, or nonmetallic floor boxes within slab above grade.
4. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
5. Manufacturer: Same as manufacturer of floor box service fittings.

2.2 ACCESSORIES

A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for boxes and facade materials to be installed.
1. Manufacturers:
a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive boxes.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide separate boxes for emergency power and normal power systems.

E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

H. Box Locations:

1. Locate boxes to be accessible. Provide access panels in accordance with Section 083100 as required where approved by the Architect.
2. Unless dimensioned, box locations indicated are approximate.
3. Locate boxes as required for devices installed under other sections or by others.
   a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 262726.
   b. Communications Systems Outlets: Comply with Section 271000.
4. Locate boxes so that wall plates do not span different building finishes.
5. Locate boxes so that wall plates do not cross masonry joints.
6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
   a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
   b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 260533.13.
11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
    a. Concealed above accessible suspended ceilings.
    b. Within joists in areas with no ceiling.
    c. Electrical rooms.
    d. Mechanical equipment rooms.

I. Box Supports:
1. Secure and support boxes in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide required seismic controls in accordance with Section 260548.
3. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
4. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
5. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.

J. Install boxes plumb and level.

K. Flush-Mounted Boxes:
   1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
   2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
   3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

L. Floor-Mounted Cabinets: Mount on properly sized 4 inch high concrete pad constructed in accordance with Section 033000.

M. Install boxes as required to preserve insulation integrity.

N. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.

O. Nonmetallic Floor Boxes: Cut box flush with finished floor after concrete pour.

P. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

Q. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

R. Close unused box openings.

S. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

T. Provide grounding and bonding in accordance with Section 260526.

U. Identify boxes in accordance with Section 260553.

3.3 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.4 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 260533.16

SECTION 260533.23 - SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surface raceway systems.

B. Wireways.

C. Wall duct.

1.2 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 260529 - Hangers and Supports for Electrical Systems.
   1. Includes metal channel (strut) used as raceway.

C. Section 260533.13 - Conduit for Electrical Systems.

D. Section 260533.16 - Boxes for Electrical Systems.

E. Section 260539 - Underfloor Raceways for Electrical Systems: Trench duct.

F. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

D. NEMA PRP 5 - Installation Guidelines for Surface Nonmetallic Raceway 2021.

E. UL 5 - Surface Metal Raceways and Fittings Current Edition, Including All Revisions.

F. UL 5A - Nonmetallic Surface Raceways and Fittings Current Edition, Including All Revisions.

G. UL 111 - Outline of Investigation for Multioutlet Assemblies Current Edition, Including All Revisions.

H. UL 870 - Wireways, Auxiliary Gutters, and Associated Fittings Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the placement of raceways with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate rough-in locations of outlet boxes provided under Section 260533.16 and conduit provided under Section 260533.13 as required for installation of raceways provided under this section.
3. Verify minimum sizes of raceways with the actual conductors and components to be installed.
4. Wall Duct: Coordinate the work with other trades to provide walls suitable for installation of flush-mounted wall duct where indicated.
5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not install raceways until final surface finishes and painting are complete.
2. Do not begin installation of conductors and cables until installation of raceways is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets including dimensions, knockout sizes and locations, materials, fabrication details, finishes, service condition requirements, and accessories.
1. Surface Raceway Systems: Include information on fill capacities for conductors and cables.

C. Shop Drawings:
1. Pre-wired Surface Raceway Systems: Provide plan and elevation views including dimensioned locations of wiring devices and circuiting arrangements.
2. Wireways: Provide dimensioned plan and elevation views including adjacent equipment with all required clearances indicated.

D. Samples: Three of each type and color of surface raceway system specified, 6 inches in length.

E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 RACEWAY REQUIREMENTS

A. Provide all components, fittings, supports, and accessories required for a complete raceway system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Do not use raceways for applications other than as permitted by NFPA 70 and product listing.

2.2 SURFACE RACEWAY SYSTEMS

A. Manufacturers:
1. Hubbell Incorporated: www.hubbell.com/#sle.
2. MonoSystems, Inc: www.monosystems.com/#sle.
3. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Surface Metal Raceways: Listed and labeled as complying with UL 5.

C. Surface Nonmetallic Raceways: Listed and labeled as complying with UL 5A.

D. Multioutlet Assemblies: Listed and labeled as complying with UL 111.

E. Metal Channel (Strut) Used as Raceway: Comply with Section 260529.

2.3 WIREWAYS

A. Manufacturers:
   1. Cooper B-Line, a division of Cooper Industries: www.cooperindustries.com/#sle.
   2. Enduro Composites: www.endurocomposites.com/#sle.
   3. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com/#sle.
   4. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
   5. Substitutions: See Section 016000 - Product Requirements.

B. Description: Lay-in wireways and wiring troughs with removable covers; listed and labeled as complying with UL 870.

C. Wireway Type, Unless Otherwise Indicated:
   1. Indoor Clean, Dry Locations: NEMA 250, Type 1, painted steel with screw-cover.
   2. Outdoor Locations: NEMA 250, Type 3R, painted steel with screw-cover; include provision for padlocking.

D. Finish for Painted Steel Wireways: Manufacturer's standard grey unless otherwise indicated.

E. Minimum Wireway Size: 4 by 4 inches unless otherwise indicated.

F. Where wireway size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.4 WALL DUCT

A. Manufacturers:
   1. Dennis Filges Company, Inc: www.filgesco.com/#sle.
   2. Hubbell Incorporated: www.hubbell.com/#sle.
   3. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
   4. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.
   5. Substitutions: See Section 016000 - Product Requirements.
   6. Source Limitations: Where the wall duct system includes connections to trench duct as specified in Section 260539, furnish wall duct and associated components produced by the same manufacturer as the trench duct to be installed.

B. Description: Metal raceways specifically designed for enclosure of wiring to X-ray machines and similar medical equipment; listed and labeled as complying with UL 870.

C. Material: Steel, unless otherwise indicated.

D. Mounting Provisions: Suitable for surface- or flush-mounting as indicated.

E. Size: As indicated on the drawings.

2.5 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Factory test each production unit for pre-wired surface raceway systems to verify proper wiring.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes and conduit terminations are installed in proper locations and are properly sized in accordance with NFPA 70 to accommodate raceways.

C. Verify that mounting surfaces are ready to receive raceways and that final surface finishes are complete, including painting.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Perform work in accordance with NECA 1 (general workmanship).

C. Surface Nonmetallic Raceways: Install in accordance with NEMA PRP 5.

D. Install raceways plumb and level.

E. Arrange wireways and associated raceway connections to comply with NFPA 70, including but not limited to requirements for deflected conductors and wireways used as pullboxes. Increase size of wireway where necessary.

F. Secure and support raceways in accordance with Section 260529 at intervals complying with NFPA 70 and manufacturer's requirements.

G. Close unused raceway openings.

H. Provide grounding and bonding in accordance with Section 260526.

I. Identify raceways in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect raceways for damage and defects.

C. Surface Raceway Systems with Integrated Devices: Test each wiring device to verify operation and proper polarity.

D. Correct wiring deficiencies and replace damaged or defective raceways.

3.4 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 PROTECTION

A. Protect installed raceways from subsequent construction operations.

END OF SECTION 260533.23

SECTION 260536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Metal cable tray systems:
   1. Metal ladder cable tray.
   2. Metal ventilated trough cable tray.
   3. Metal solid-bottom cable tray.
   4. Metal single rail/center spine cable tray.
   5. Metal channel cable tray.
   6. Metal wire mesh/basket cable tray.

1.2 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 260526 - Grounding and Bonding for Electrical Systems.

C. Section 260529 - Hangers and Supports for Electrical Systems.

D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.

C. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings 2020.

D. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2019.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

F. NEMA VE 1 - Metal Cable Tray Systems 2017.

G. NEMA VE 2 - Cable Tray Installation Guidelines 2018.

H. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the arrangement of cable tray with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others. Coordinate the work with other trades to avoid installation of obstructions within cable tray required clearances.
   2. Coordinate arrangement of cable tray with the dimensions and clearance requirements of the actual products to be installed.
   3. Coordinate the work with placement of supports, anchors, etc. required for mounting.
   4. Notify of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week prior to commencing work of this section; require attendance of all affected installers. Review proposed routing, sequence of installation, and protection requirements for installed cable tray.

C. Sequencing:
   1. Do not begin installation of cables until installation of associated cable tray run is complete.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cable tray system components and accessories. Include dimensions, materials, fabrication details, finishes, and span/load ratings.

C. Shop Drawings: Include dimensioned plan views and sections indicating proposed cable tray routing, required clearances, and locations and details of supports, fittings, building element penetrations, and equipment connections.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Project Record Documents: Record actual routing of cable tray and locations of supports.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and NEMA VE 2, except do not store cable tray outdoors without cover as permitted in NEMA VE 2.

B. Handle products carefully to avoid damage to finish.

PART 2 PRODUCTS

2.1 CABLE TRAY SYSTEM - GENERAL REQUIREMENTS

A. Provide new cable tray system consisting of all required components, fittings, supports, accessories, etc. as necessary for a complete system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Do not use cable tray for applications other than as permitted by NFPA 70 and product listing/classification.

D. Provide cable tray system and associated components suitable for use at indicated span/load ratings under the service conditions at the installed location.

E. Unless otherwise indicated, specified span/load ratings are based on safety factor of 1.5 and working load only (no additional concentrated static load), with ratings for metal cable tray systems in accordance with NEMA VE 1.

F. Unless otherwise indicated, specified load/fill depths and inside widths are nominal values, with values for metal cable tray systems in accordance with NEMA VE 1 including applicable allowable tolerances.

2.2 METAL CABLE TRAY SYSTEMS

A. Manufacturers:
   1. Metal Cable Tray System: Acceptable manufacturers
      a. Cablofil, a brand of Legrand North America, Inc: www.legrand.us/#sle.
      b. Chalfant Manufacturing Company: www.chalfant-obo.com/#sle.
      c. Cope, a brand of Atkore International Inc: www.copecabletray.com/#sle.
      d. Thomas & Betts Corporation: www.tnb.com/#sle.
   2. Source Limitations: Furnish cable tray system and associated components and accessories produced by a single manufacturer and obtained from a single supplier.

B. Comply with NEMA VE 1.

C. Finishes:
   1. Zinc Electroplated Steel: Comply with ASTM B633.
   2. Mill-Galvanized Before Fabrication (Pre-Galvanized) Steel: Comply with ASTM A653/A653M, G90 coating.
   3. Hot-Dip Galvanized After Fabrication (H.D.G.A.F.) Steel: Comply with ASTM A123/A123M.
   4. Stainless Steel: Type 304 or Type 316.

D. Metal Ladder Cable Tray:
   1. Material: Mill-galvanized before fabrication (pre-galvanized) steel.
   2. Side Rail Construction: I-beam, C-channel flange out, or C-channel flange in.
   3. Load/Fill Depth: As indicated on drawings.
   4. Span/Load Rating: As indicated on drawings.
   5. Rung Spacing: 9 inches on center for straight lengths.
   6. Inside Width: As indicated on drawings.
   7. Inside Radius of Fittings: 12 inches.

E. Metal Ventilated Trough Cable Tray:
   1. Material: Mill-galvanized before fabrication (pre-galvanized) steel.
   2. Bottom Type: Vented corrugated.
   3. Load/Fill Depth: As indicated on drawings.
   4. Span/Load Rating: As indicated on drawings.
   5. Inside Width: As indicated on drawings.
   6. Inside Radius of Fittings: 12 inches.

F. Metal Solid-Bottom Cable Tray:
   1. Material: Mill-galvanized before fabrication (pre-galvanized) steel.
   2. Bottom Type: Solid corrugated or flat.
   3. Load/Fill Depth: As indicated on drawings.
   4. Span/Load Rating: As indicated on drawings.
   5. Inside Width: As indicated on drawings.
   6. Inside Radius of Fittings: 12 inches.

G. Metal Single Rail/Center Spine Cable Tray:
   1. Material: Mill-galvanized before fabrication (pre-galvanized) steel.
   2. Configuration: Center rail or wall mount as indicated.
   3. Number of Tiers: Single tier.
   4. Load/Fill Depth: As indicated on drawings.
   5. Span/Load Rating: As indicated on drawings.
   6. Rung Spacing: 9 inches on center for straight lengths.
   7. Inside Width: As indicated on drawings.
   8. Inside Radius of Fittings: 12 inches.

H. Metal Channel Cable Tray:

1. Material: Mill-galvanized before fabrication (pre-galvanized) steel.
2. Bottom Type: Solid bottom.
3. Tray Depth: 1-3/4 inches.
4. Span/Load Rating: As indicated on drawings.
5. Tray Width: 4 inches.
6. Inside Radius of Fittings: 12 inches.

I. Metal Wire Mesh/Basket Cable Tray:
1. Material: Zinc electroplated steel or mill-galvanized before fabrication (pre-galvanized) steel.
2. Tray Depth: As indicated on drawings.
3. Span/Load Rating: As indicated on drawings.
4. Mesh Spacing: 2 by 4 inches.
5. Tray Width: As indicated on drawings.

2.3 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Metal Cable Tray: Perform factory design tests in accordance with NEMA VE 1, including electrical continuity and load testing.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that work likely to damage cable tray system has been completed.

B. Verify that field measurements are as indicated.

C. Verify that the dimensions and span/load ratings of cable tray system components are consistent with the indicated requirements.

D. Verify that mounting surfaces are ready to receive cable tray and associated supports.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install cable tray in accordance with NECA 1 (general workmanship), and NEMA VE 2.

C. Unless otherwise indicated, arrange cable tray to be parallel or perpendicular to building lines.

D. Arrange cable tray to provide required clearances and maintain cable access.

E. Install cable tray plumb and level, with sections aligned and with horizontal runs at the proper elevation.

F. Metal Wire Mesh/Basket Cable Tray: Field fabricate fittings in accordance with manufacturer's instructions, using only manufacturer-approved connectors classified for bonding.
   1. Inside Radius of Fittings: 12 inches.

G. Hot-Dip Galvanized After Fabrication (H.D.G.A.F.) Steel Cable Tray: After cutting, drilling, or deburring, use approved zinc-rich paint to repair finish in accordance with ASTM A780/A780M.

H. Cable Tray Movement Provisions:
   1. Provide suitable expansion fittings where cable tray is subject to movement, including but not limited to:
      a. Where cable tray crosses structural joints intended for expansion.
      b. Long straight cable tray runs in accordance with NEMA VE 2.
   2. Use expansion guides in lieu of hold-down clamps where prescribed in NEMA VE 2.
   3. Set gaps for expansion fittings in accordance with NEMA VE 2.

I. Cable Provisions:
   1. Use suitable fixed barrier strips to maintain separation of cables as indicated and as required by NFPA 70.
   2. Use suitable drop-out fittings or bushings where cables exit cable tray as required to maintain minimum cable bending radius.
   3. Use suitable cable support fittings for long vertical cable tray runs with heavy cables.

J. Provide end closures at unconnected ends of cable tray runs.

K. Cable Tray Support:
   1. Use manufacturer's recommended hangers and supports, located in accordance with NEMA VE 2 and manufacturer's requirements, but not exceeding specified span unless otherwise approved by Engineer. Provide required support and attachment in accordance with Section 260529, where not furnished by cable tray manufacturer.
   2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

L. Grounding and Bonding Requirements, in Addition to Requirements of Section 260526:
   1. Comply with grounding and bonding requirements of NEMA VE 2.
   2. Metal Cable Tray Systems: Use suitable bonding jumpers or classified connectors to provide electrical continuity.
   3. Provide suitable equipment grounding conductor in each cable tray, except where cable tray contains only multiconductor cables with integral equipment grounding conductors. Do not use metal cable tray system as sole equipment grounding conductor.

M. Conduit Termination:

1. Use listed cable tray conduit clamps (evaluated for bonding connection) to terminate conduits at cable tray.
2. Provide insulating bushing at conduit termination to protect cables.
3. Provide independent support for conduit.

N. Cable Installation:
1. Comply with cable installation requirements of NEMA VE 2.
2. Use appropriate cable pulling tools, applied to prevent excessive force on cable tray system and maintain minimum cable bending radius.
3. Use cable clamps or cable ties to fasten conductors/cables to vertical and horizontal runs of cable tray.
   a. Distance Between Fastening Points for Vertical Runs: 18 inches.
   b. Distance Between Fastening Points for Horizontal Runs: As required to maintain spacing and confine conductor/cable within the cable fill area.

O. Penetrations: Install firestopping to preserve fire resistance rating of building elements, using materials and methods specified in Section 078400.

P. Identification Requirements, in Addition to Those Specified in Section 260553.

Q. Install cable tray covers where indicated and as follows:
1. For first 6 feet of cable tray extending vertically from a floor penetration.
2. Where cable tray passes under open walkways.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect cable tray system for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective cable tray system components.

3.4 ADJUSTING

A. Adjust tightness of mechanical connections to manufacturer's recommended torque settings.

3.5 CLEANING

A. Remove dirt and debris from cable tray.

B. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.6 PROTECTION

A. Protect cable tray system from subsequent construction operations.

END OF SECTION 260536

SECTION 260539 - UNDERFLOOR RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Underfloor duct.

B. Flush infloor duct.

C. Trench duct.

D. Service fittings.

1.2 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 260533.23 - Surface Raceways for Electrical Systems: Wall duct.

C. Section 262726 - Wiring Devices.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. UL 884 - Underfloor Raceways and Fittings Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the work with other trades for the proper placement of concrete provided under other sections.
   1. Verify that no concrete containing chlorides from any source will be used in contact with duct system.
   2. Where approved by the Engineer, arrange for vibration of concrete at duct system to ensure complete fill beneath components.
   3. Arrange for hand finishing of concrete adjacent to flush components.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Include dimensioned plan views and sections indicating system layout, connection locations and details, insert spacing and height, and service fitting locations.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including dimensions, materials, fabrication details, finishes, conductor and cable fill capacities, service condition requirements, and accessories.

D. Samples:
1. Trench Duct: One section including cover with trim to be installed.
2. Junction Boxes: One of each type including cover with trim to be installed.
3. Service Fittings: One of each type and finish specified.

E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

F. Project Record Documents: Record actual installed locations of ducts, junction boxes, and service fittings.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 016000 - Product Requirements, for additional provisions.
2. Extra Afterset Inserts: Quantity equal to 15 percent of total installed service fittings.
3. Extra Service Fittings: Quantity equal to 15 percent of total installed preset inserts.
4. Electronic Tools for Locating Inserts: One.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 DUCT SYSTEM REQUIREMENTS

A. Provide all components, fittings, supports, and accessories required for a complete duct system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Do not use duct systems for applications other than as permitted by NFPA 70 and product listing.

2.2 UNDERFLOOR DUCT

A. Manufacturers:
1. Dennis Filges Company, Inc: www.filgesco.com/#sle.
2. Hubbell Incorporated: www.hubbell.com/#sle.
3. Substitutions: See Section 016000 - Product Requirements.

B. Configuration: Distribution and header underfloor duct for single service or multiple services as indicated on drawings; for multiple services use multiple compartment duct or parallel single compartment ducts positioned together.

C. Underfloor Duct:
1. Description: Steel duct with corrosion-resistant coating, designed for installation beneath concrete floor surface; suitable for use as underfloor raceway and listed and labeled as complying with UL 884.
2. Compartment Size:
   a. Distribution Duct: As indicated on the drawings.
   b. Header Duct: Same as specified for distribution duct unless otherwise indicated.
3. Preset Inserts:
   a. Distribution Duct:
      1) Type: As required to accommodate specified service fittings.
      2) Height: Selected according to depth of concrete cover.
      3) Spacing: 24 inches.
      4) Furnish with removable cap recessed to hold concrete.
   b. Header Duct: None (blank duct).

D. Junction Boxes: Standard duty unless otherwise indicated.
1. Provide junction box(es) for connections and intersections of duct runs as indicated or as required for duct configuration installed.

2. Junction Boxes: Furnished with openings on four sides for duct connections and openings on four corners for conduit connections; with partitions to separate multiple services; with integral means for leveling adjustment prior to concrete pour.
3. Height: Selected according to duct to be installed and depth of concrete cover.
4. Cover Plate: Furnished with trim suitable for flooring to be installed.

E. Duct Supports: Steel with corrosion-resistant coating, with integral means for leveling adjustment prior to concrete pour; height to be selected according to duct to be installed and depth of concrete cover.

F. Marker Caps: Preset insert caps with integral marker screw for indicating location of duct run after concrete pour; provide different material screws for distinguishing between power and communications duct runs.

2.3 FLUSH INFLOOR DUCT

A. Manufacturers:
1. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.
2. Substitutions: See Section 016000 - Product Requirements.

B. Configuration: Distribution and header flush infloor duct for single service or multiple services as indicated on drawings.

C. Flush Infloor Duct:
1. Description: Steel duct with corrosion-resistant coating, designed for installation flush with concrete floor surface; suitable for use as underfloor raceway and listed and labeled as complying with UL 884.
2. Compartment Size: As indicated on the drawings .
3. Preset Openings:
a. Distribution Duct:
1) Type: Round, 1-5/8 inch (41mm) diameter threaded.
2) Spacing: 24 inches.
3) Furnish with removable threaded plug.
b. Header Duct: None (blank duct).

D. Junction Boxes:
1. Provide junction box(es) for connections and intersections of duct runs as indicated or as required for duct configuration installed.
2. Junction Boxes: Furnished with openings on four sides for duct connections and openings on four corners for conduit connections; with partitions to separate multiple services; with integral means for leveling adjustment prior to concrete pour.
3. Cover Plate: Furnished with trim suitable for flooring to be installed.

E. Duct Supports: Steel with corrosion-resistant coating, with integral means for leveling adjustment prior to concrete pour.

2.4 TRENCH DUCT

A. Manufacturers:
   1. Dennis Filges Company, Inc: www.filgesco.com/#sle.
   2. Hubbell Incorporated: www.hubbell.com/#sle.
   3. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
   4. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.
   5. Substitutions: See Section 016000 - Product Requirements.
   6. Source Limitations: Where the trench duct system includes connections to wall duct as specified in Section 260533.23, furnish trench duct and associated components produced by the same manufacturer as the wall duct to be installed.

B. Trench Duct:
   1. Description: Steel duct with corrosion-resistant coating, designed for installation flush with concrete floor surface; furnished with removable gasketed covers for lay-in installation of conductors and cables.
   2. Size: As indicated on the drawings.
   3. Compartments:
      a. Provide adjustable compartment dividers for multiple services as indicated on drawings.
      b. Compartment Size: As indicated on the drawings.

C. Duct Supports: Steel with corrosion-resistant coating, with integral means for leveling adjustment prior to concrete pour.

D. Cover Plates: Minimum 1/4 inch thick steel, furnished with trim suitable for flooring to be installed.

2.5 SERVICE FITTINGS

A. Manufacturer: Same as manufacturer of duct system to be installed.

B. Description: Service fittings compatible with duct system to be installed with all components, adapters, and trims required for complete installation.

C. Receptacles: Comply with Section 262726.

D. Finishes: As specified for floor box service fittings in Section 262726.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Perform work in accordance with NECA 1 (general workmanship).

C. Unless otherwise indicated, arrange duct to be parallel or perpendicular to building lines.

D. Install duct supports located according to manufacturer's recommendations, but not exceeding 5 feet between supports. Permanently fasten duct supports to the supporting framework.

E. Provide expansion fittings with suitable bonding jumper where duct crosses structural joints intended for expansion.

F. Make adjustments such that duct is level at the proper elevation. Unless otherwise indicated, adjust as follows:
   1. Underfloor Duct: Tops of inserts 1/8 to 3/8 inch below screed line or as required by manufacturer.
   2. Flush Infloor Duct: Top of duct even with screed line.
   3. Trench Duct: Top of cover plate assembly flush with finished floor, accounting for flooring material and associated trim.

G. Install marker caps in each insert adjacent to junction boxes, at end of each duct run, on both sides of permanent partitions, and on both sides of change in direction of duct. Adjust markers to be flush with finished floor except only extend through backing material for carpeted areas.

H. Provide grounding and bonding in accordance with Section 260526.

I. Prior to concrete placement, seal duct system connections and openings with duct tape or manufacturer's recommended compound to prevent entry of concrete.

J. Install service fittings after installation of floor finishes. Cut floors according to manufacturer's instructions as required.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect duct system components for damage and defects.

C. Service Fittings: Test each wiring device to verify operation and proper polarity.

D. Correct wiring deficiencies and replace damaged or defective duct system components.

E. Repair or replace floors damaged as a result of work of this section.

3.4 ADJUSTING

A. Adjust duct system covers to eliminate movement and noise under normal traffic.

3.5 CLEANING

A. After concrete placement and before installation of conductors and cables, clean interior of duct system to remove moisture and foreign matter.

B. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.6 PROTECTION

A. Prior to concrete placement, do not use installed duct system as walkway or working platform.

B. Protect installed duct system from subsequent construction operations. Do not allow equipment or heavy traffic over the duct system without using ramps that ensure load is not transferred to the duct.

END OF SECTION 260539

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SECTION 260548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Vibration isolation requirements.

B. Seismic control requirements.
   1. Includes requirements for seismic qualification of equipment not specified in this section.

C. Vibration-isolated equipment support bases.

D. Vibration isolators.

E. External seismic snubber assemblies.

F. Seismic restraint systems.

1.2 RELATED REQUIREMENTS

A. Section 014533 - Code-Required Special Inspections and Procedures.

B. Section 033000 - Cast-in-Place Concrete.

C. Section 055000 - Metal Fabrications: Materials and requirements for fabricated metal supports.

1.3 DEFINITIONS

A. Electrical Component: Where referenced in this section in regards to seismic controls, applies to any portion of the electrical system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g., conduit, cable tray).

B. Seismic Restraint: Structural members or assemblies of members or manufactured elements specifically designed and applied for transmitting seismic forces between components and the seismic force-resisting system of the structure.

1.4 REFERENCE STANDARDS

A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.

B. ASCE 19 - Structural Applications of Steel Cables for Buildings 2016.

C. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications Most Recent Edition Cited by Referring Code or Reference Standard.

D. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions 2022.

E. FEMA 413 - Installing Seismic Restraints for Electrical Equipment 2004.

F. FEMA E-74 - Reducing the Risks of Nonstructural Earthquake Damage 2012.

G. ICC (IBC) - International Building Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. ICC-ES AC156 - Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components 2010, with Editorial Revision (2015).

I. MFMA-4 - Metal Framing Standards Publication 2004.

J. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

K. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems 2008.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Seismic Controls:
      a. Coordinate the arrangement of seismic restraints with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
      b. Coordinate the work with other trades to accommodate relative positioning of essential and nonessential components in consideration of seismic interaction.
   5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.6 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Design Documents: Prepare and submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, details, and calculations.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
   1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.
   2. Seismic Controls: Include seismic load capacities.

D. Shop Drawings - Vibration Isolation Systems:
   1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators; indicate equipment weights and static deflections.
   2. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable; indicate equipment mounting provisions.

E. Shop Drawings - Seismic Controls:
   1. Include dimensioned plan views and sections indicating proposed electrical component locations and distributed system routing, with locations and details of gravity supports and seismic restraints and associated attachments.
   2. Identify mounting conditions required for equipment seismic qualification.
   3. Identify anchor manufacturer, type, minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
   4. Indicate proposed arrangement of distributed system trapeze support groupings.
   5. Indicate proposed locations for distributed system flexible fittings and/or connections.
   6. Indicate locations of seismic separations where applicable.

F. Seismic Design Data:
   1. Compile information on project-specific characteristics of actual installed electrical components necessary for determining seismic design forces required to design appropriate seismic controls, including but not limited to the following.

G. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

H. Manufacturer’s detailed field testing and inspection procedures.

I. Field quality control test reports.

1.7 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with applicable building code.

C. Seismic Controls Designer Qualifications: Registered professional engineer licensed in the State in which the Project is located and with minimum five years experience designing seismic restraints for nonstructural components.
   1. Designer may be employed by the manufacturer of the seismic restraint products.

D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 VIBRATION ISOLATION REQUIREMENTS

A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing electrical equipment and/or electrical connections to vibration-isolated equipment.

B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:

C. General Requirements:
   1. Select vibration isolators to provide required static deflection.
   2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.
   3. Select seismic type vibration isolators to comply with seismic design requirements, including conditions of equipment seismic certification where applicable.
   4. Select vibration isolators for outdoor equipment to comply with wind design requirements.
   5. Select vibration-isolated equipment support bases and associated vibration isolators to provide minimum 2-inch operating clearance beneath base unless otherwise indicated.

D. Conduit Isolation:
   1. Use flexible conduit or cable for electrical connections to vibration-isolated equipment, including equipment installed under other sections or by others.
   2. Vibration Isolators:
      a. Provide vibration isolators for conduit supports:
         1) Located within 50 feet of connected vibration-isolated equipment where flexible connection to equipment is not possible.

         2) For conduits over 2 inch trade size located below or within 50 feet of noise-sensitive areas indicated.

      b. Minimum Static Deflection:

1) First Three Supports Closest to Isolated Equipment: Same as static deflection of equipment; maximum of 2 inch deflection required.

2) Remainder of Supports: 0.75 inch deflection unless otherwise indicated.

c. Suspended Conduits, Nonseismic Applications: Use resilient material isolator hangers, spring isolator hangers, or combination resilient material/spring isolator hangers.
d. Suspended Conduits, Seismic Applications: Use seismic type resilient material isolator hangers, seismic type spring isolator hangers, or seismic type combination resilient material/spring isolator hangers.
e. Use modular seal or approved resilient material where vibration-isolated conduits penetrate building elements (e.g., walls, floors) arranged to prevent vibration transmission to structure.

2.2 SEISMIC CONTROL REQUIREMENTS

A. Design and provide electrical component restraints, supports, and attachments suitable for seismic loads determined in accordance with applicable codes, as well as gravity and operating loads and other structural design considerations of the installed location. Consider wind loads for outdoor electrical components.

B. Seismic Design Criteria: ICC (IBC).

C. Component Importance Factor (Ip): Electrical components to be assigned a component importance factor (Ip) of 1.5 unless otherwise indicated.

D. Seismic Qualification of Equipment:
1. Provide special certification for electrical equipment furnished under other sections and assigned a component importance factor (Ip) of 1.5, certifying that equipment will remain operable following a design level earthquake.
2. Seismic qualification to be by shake table testing in accordance with recognized testing standard procedure, such as ICC-ES AC156, acceptable to authorities having jurisdiction.
3. Notify Engineer and obtain direction where mounting restrictions required by conditions of seismic certification conflict with specified requirements.
4. Seismically qualified equipment to be furnished with factory-installed labels referencing certificate of compliance and associated mounting restrictions.

E. Seismic Restraints:
1. Provide seismic restraints for electrical components except where exempt according to applicable codes and specified seismic design criteria, as approved by authorities having jurisdiction.
2. Seismic Restraint Exemptions:
a. Conduit, Cable Tray, and Raceway Exemptions, All Seismic Design Categories:

1) Raceways with component importance factor (Ip) of 1.0 where flexible connections are provided between cable tray or raceway and associated components, where cable tray or raceway is positively attached to the structure, and where one of the following apply:

(a) Trapeze supported conduits, cable trays, or raceways with trapeze assemblies using 3/8 inch diameter rod hangers not exceeding 12 inches in length from support point connection to the supporting structure, and the total weight supported by any single trapeze is 100 pounds or less.

(b) Trapeze supported conduits, cable trays, or raceways with trapeze assemblies using 1/2 inch diameter rod hangers not exceeding 12 inches in length from support point connection to the supporting structure, and the total weight supported by any single trapeze is 200 pounds or less.

(c) Trapeze supported conduits, cable trays, or raceways with trapeze assemblies using 1/2 inch diameter rod hangers not exceeding 24 inches in length from support point connection to the supporting structure, and the total weight supported by any single trapeze is 100 pounds or less.

(d) Hanger supported conduits, cable trays, or raceways with individual rod hangers 3/8 inch or 1/2 inch in diameter not exceeding 12 inches in length from support point connection to the supporting structure, and the total weight supported by any single rod is 50 pounds or less.

2) Conduits less than 2-1/2 inch trade size.

b. Lighting Exemptions, All Seismic Design Categories:

1) Suspended luminaires where attachments are designed to accommodate 1.4 times the operating weight acting in both the vertical and horizontal directions and connections to structure allow for 360 degree range of motion in the horizontal plane; arrange to prevent impact between luminaires and the structure or other nonstructural components.

2) Lay-in luminaires weighing less than 56 pounds secured to ceiling grid and provided with safety wires in accordance with ASTM E580/E580M.

3. Comply with applicable general recommendations of the following, where not in conflict with applicable codes, seismic design criteria, or other specified requirements:
   a. ASHRAE (HVACA).
   b. FEMA 413.
   c. FEMA E-74.
   d. SMACNA (SRM).
4. Seismic restraint capacities to be verified by a Nationally Recognized Testing Laboratory (NRTL) or certified by an independent third-party registered professional engineer acceptable to authorities having jurisdiction.
5. Seismic Type Vibration Isolators:

a. Comply with seismic design requirements, including conditions of equipment seismic certification where applicable.

6. External Seismic Snubber Assemblies:
   a. Provide quantity and arrangement of external seismic snubber assemblies as required to restrain equipment in all directions (both lateral and vertical).
   b. Do not use external seismic snubber assemblies that restrain equipment only in one or more lateral directions (but not vertical) except where uplift forces are zero or are addressed by other restraints.
7. Seismic Restraint Systems:
   a. Except where otherwise restricted, use of either cable or rigid restraints is permitted.
   b. Use only cable restraints to restrain vibration-isolated electrical components, including distributed systems.
   c. Use only one restraint system type for a given electrical component or distributed system (e.g., conduit, cable tray) run; mixing of cable and rigid restraints on a given component/run is not permitted.
   d. Size restraint elements, including anchorage, to resist seismic loads as necessary to restrain electrical component in all lateral directions; consider bracket geometry in anchor load calculations.
   e. Use rod stiffener clips to attach bracing to hanger rods as required to prevent rod buckling from vertical (upward) compressive load introduced by cable or rigid restraints loaded in tension, in excess of downward tensile load due to supported electrical component weight.
   f. Select hanger rods and associated anchorage as required to accommodate vertical (downward) tensile load introduced by rigid restraints loaded in compression, in addition to downward tensile load due to supported electrical component weight.
   g. Clevis hangers may only be used for attachment of transverse restraints; do not use for attachment of longitudinal restraints.
   h. Where seismic restraints are attached to clevis hangers, provide clevis bolt reinforcement accessory to prevent clevis hanger deformation.
   i. Do not introduce lateral loads on open bar joist chords or the weak axis of beams, or loads in any direction at other than panel points unless approved by project Structural Engineer of Record.

F. Seismic Attachments:
   1. Attachments to be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity.
   2. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) or qualified evaluation service acceptable to authorities having jurisdiction for compliance with applicable building code, and qualified for seismic applications; concrete anchors to be qualified for installation in both cracked and uncracked concrete.
   3. Do not use power-actuated fasteners.
   4. Do not use friction clips (devices that rely on mechanically applied friction to resist loads). Beam clamps may be used for supporting sustained loads where provided with restraining straps.

5. Comply with anchor minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
6. Concrete Housekeeping Pads:
    a. Increase size of pad as required to comply with anchor requirements.
    b. Provide pad reinforcement and doweling to ensure integrity of pad and connection and to provide adequate load path from pad to supporting structure.

G. Seismic Interactions:
1. Include provisions to prevent seismic impact between electrical components and other structural or nonstructural components.
2. Include provisions such that failure of a component, either essential or nonessential, does not cause the failure of an essential component.

H. Seismic Relative Displacement Provisions:
1. Use suitable fittings or flexible connections to accommodate:
    a. Relative displacements at connections between components, including distributed systems (e.g., conduit, cable tray); do not exceed load limits for equipment utility connections.
    b. Relative displacements between component supports attached to dissimilar parts of structure that may move differently during an earthquake.
    c. Design displacements at seismic separations.
    d. Anticipated drifts between floors.

2.3 VIBRATION-ISOLATED EQUIPMENT SUPPORT BASES

A. Manufacturers:
1. Vibration-Isolated Equipment Support Bases:
    a. Kinetics Noise Control, Inc: www.kineticsnoise.com/#sle.
    b. Mason Industries: www.mason-ind.com/#sle.
    c. Vibration Eliminator Company, Inc: www.veco-nyc.com/#sle.
2. Substitutions: See Section 016000 - Product Requirements.
3. Source Limitations: Furnish vibration-isolated equipment support bases and associated components and accessories produced by the same manufacturer as the vibration isolators and obtained from a single supplier.

B. Vibration-Isolated Structural Steel Bases:
1. Description: Engineered structural steel frames with integral mounting provisions for vibration isolators, sized and configured for mounting of equipment.

C. Vibration-Isolated Concrete Inertia Bases:
1. Description: Concrete-filled engineered steel forms with integral mounting provisions for vibration isolators, sized and configured for mounting of equipment.
2. Minimum Base Depth: 6 inches.
3. Minimum Base Mass (Including Concrete): 1.5 times weight of supported equipment.
4. Concrete Reinforcement: Welded or tied reinforcing bars running both ways in a single layer.

5. Concrete: Filled on site with minimum 3000 psi concrete in accordance with Section 033000.

2.4 VIBRATION ISOLATORS

A. Manufacturers:
   1. Vibration Isolators:
      a. Kinetics Noise Control, Inc: www.kineticsnoise.com/#sle.
      b. Mason Industries: www.mason-ind.com/#sle.
      c. Vibration Eliminator Company, Inc: www.veco-nyc.com/#sle.
   2. Substitutions: See Section 016000 - Product Requirements.
   3. Source Limitations: Furnish vibration-isolators and associated accessories produced by a single manufacturer and obtained from a single supplier.

B. General Requirements:
   1. Resilient Materials for Vibration Isolators: Oil, ozone, and oxidant resistant.
   2. Spring Elements for Spring Isolators:
      a. Color code or otherwise identify springs to indicate load capacity.
      b. Lateral Stability: Minimum lateral stiffness to vertical stiffness ratio of 0.8.
      c. Designed to operate in the linear portion of their load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
      d. Designed to provide additional travel to solid of not less than 50 percent of rated deflection at rated load.
      e. Selected to provide designed deflection of not less than 75 percent of specified deflection.
      f. Selected to function without undue stress or overloading.
   3. Seismic Snubbing Elements for Seismic Isolators:
      a. Air Gap: Between 0.125 inches and 0.25 inches unless otherwise indicated.
      b. Points of Contact: Cushioned with resilient material, minimum 0.25 inch thick; capable of being visually inspected for damage and replaced.

2.5 EXTERNAL SEISMIC SNUBBER ASSEMBLIES

A. Manufacturers:
   1. External Seismic Snubber Assemblies:
      a. Kinetics Noise Control, Inc: www.kineticsnoise.com/#sle.
      b. Mason Industries: www.mason-ind.com/#sle.
      c. Vibration Eliminator Company, Inc: www.veco-nyc.com/#sle.
   2. Substitutions: See Section 016000 - Product Requirements.
   3. Source Limitations: Furnish external seismic snubber assemblies and associated accessories produced by the same manufacturer as the vibration isolators and obtained from a single supplier.

B. Description: Steel snubbing assemblies designed for external attachment to both equipment and supporting structure that, as part of a complete system, restrain equipment motion in all directions during a seismic event while maintaining vibration isolation during normal operation.

C. Seismic Snubbing Elements:
   1. Air Gap: Between 0.125 inches and 0.25 inches unless otherwise indicated.
   2. Points of Contact: Cushioned with resilient material, minimum 0.25 inch thick; capable of being visually inspected for damage and replaced.

2.6 SEISMIC RESTRAINT SYSTEMS

A. Manufacturers:
   1. Seismic Restraint Systems:
      a. AFCON, a brand of Anvil International: www.anvilintl.com/#sle.
      b. Eaton Corporation: www.eaton.com/#sle.
      c. Kinetics Noise Control, Inc: www.kineticsnoise.com/#sle.
      d. Mason Industries: www.mason-ind.com/#sle.
   2. Substitutions: See Section 016000 - Product Requirements.
   3. Source Limitations: Furnish seismic restraint system components and accessories produced by a single manufacturer and obtained from a single supplier.

B. Description: System components and accessories specifically designed for field assembly and attachment of seismic restraints.

C. Cable Restraints:
   1. Comply with ASCE 19.
   2. Cables: Pre-stretched, galvanized steel wire rope with certified break strength.
   3. Cable Connections: Use only swaged end fittings. Cable clips and wedge type end fittings are not permitted in accordance with ASCE 19.
   4. Use protective thimbles for cable loops where potential for cable damage exists.

D. Rigid Restraints: Use MFMA-4 steel channel (strut), steel angle, or steel pipe for structural element; suitable for both compressive and tensile design loads.

PART 3 EXECUTION

3.1 EXAMINATION

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

B. Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 CODE-REQUIRED SPECIAL INSPECTIONS

A. Arrange work to accommodate tests and/or inspections performed by Special Inspection Agency employed by Owner or Engineer in accordance with Section 014533 and statement of special inspections as required by applicable building code.

B. Frequency of Special Inspections: Where special inspections are designated as continuous or periodic, arrange work accordingly.
   1. Continuous Special Inspections: Special Inspection Agency to be present in the area where the work is being performed and observe the work at all times the work is in progress.
   2. Periodic Special Inspections: Special Inspection Agency to be present in the area where work is being performed and observe the work part-time or intermittently and at the completion of the work.

C. Seismic special inspections include, but are not limited to:
   1. Seismically Qualified Equipment: Verification that label, anchorage, and mounting comply with certificate of compliance.

D. Prior to starting work, Contractor to submit written statement of responsibility to authorities having jurisdiction and to Owner acknowledging awareness of special requirements contained in the statement of special inspections.

E. Special Inspection Agency services do not relieve Contractor from performing inspections and testing specified elsewhere.

3.3 INSTALLATION

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

B. Install products in accordance with applicable requirements of NECA 1 (general workmanship).

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Secure fasteners according to manufacturer's recommended torque settings.

E. Field-Welding (where approved by Engineer): Comply with Section 055000.

F. Install flexible conduit and cable connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.

G. Vibration Isolation Systems:
   1. Vibration-Isolated Equipment Support Bases:
      a. Provide specified minimum clearance beneath base.
   2. Spring Isolators:
      a. Position equipment at operating height; provide temporary blocking as required.

b. Lift equipment free of isolators prior to lateral repositioning to avoid damage to isolators.
c. Level equipment by adjusting isolators gradually in sequence to raise equipment uniformly such that excessive weight or stress is not placed on any single isolator.

3. Isolator Hangers:
a. Use precompressed isolator hangers where required to facilitate installation and prevent damage to equipment utility connection provisions.
b. Locate isolator hangers at top of hanger rods in accordance with manufacturer's instructions.

4. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
5. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
6. Adjust isolators to be free of isolation short circuits during normal operation.
7. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.

H. Seismic Controls:
1. Provide specified snubbing element air gap; remove any factory-installed spacers, debris or other obstructions.
2. Use only specified components, anchorage, and hardware evaluated by seismic design. Comply with conditions of seismic certification where applicable.
3. Where mounting hole diameter exceeds bolt diameter by more than 0.125 inch, use epoxy grout, elastomeric grommet, or welded washer to reduce clearance to 0.125 inch or less.
4. Equipment with Sheet Metal Housings:
a. Use Belleville washers to distribute stress over a larger surface area of the sheet metal connection interface as approved by manufacturer.
b. Attach additional steel as approved by manufacturer where required to transfer loads to structure.
c. Where mounting surface is irregular, do not shim housing; reinforce housing with additional steel as approved by manufacturer.

5. Concrete Housekeeping Pads:
a. Size in accordance with seismic design to meet anchor requirements.
b. Install pad reinforcement and doweling in accordance with seismic design to ensure integrity of pad and associated connection to slab.

6. Seismic Restraint Systems:
a. Do not attach seismic restraints and gravity supports to dissimilar parts of structure that may move differently during an earthquake.
b. Install restraints within permissible angles in accordance with seismic design.
c. Install cable restraints straight between component/run and structural attachment; do not bend around other nonstructural components or structural elements.
d. Install cable restraints for vibration-isolated components slightly slack to prevent short-circuiting of isolation.
e. Install hanger rod stiffeners where indicated using only specified clamps; do not weld stiffeners to hanger rod.

3.4 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect vibration isolation and/or seismic control components for damage and defects.

C. Provide services of a manufacturer's authorized representative for vibration isolation systems and seismic controls to observe installation and assist in inspection and testing. Include manufacturer's detailed testing and inspection procedures and field reports with submittals.

D. Vibration Isolation Systems:
   1. Verify isolator static deflections.
   2. Verify required clearance beneath vibration-isolated equipment support bases.
   3. Verify vibration isolation performance during normal operation; investigate sources of isolation short circuits.

E. Seismic Controls:
   1. Verify snubbing element air gaps.

F. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.

G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.5 ATTACHMENTS

A. Statement of special inspections.

END OF SECTION 260548

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SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Voltage markers.

E. Underground warning tape.

F. Floor marking tape.

G. Warning signs and labels.

1.2 RELATED REQUIREMENTS

A. Section 099113 - Exterior Painting.

B. Section 099123 - Interior Painting.

C. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

D. Section 260536 - Cable Trays for Electrical Systems: Additional identification requirements for cable tray systems.

E. Section 260573 - Power System Studies: Arc flash hazard warning labels.

F. Section 262300 - Low-Voltage Switchgear: Factory-installed mimic bus.

G. Section 262726 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.

H. Section 263100 - Photovoltaic Collectors: Additional identification requirements for photovoltaic systems.

1.3 REFERENCE STANDARDS

A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs 2011 (Reaffirmed 2017).

B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels 2011 (Reaffirmed 2017).

C. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. NFPA 70E - Standard for Electrical Safety in the Workplace 2021.

E. UL 969 - Marking and Labeling Systems Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:
1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
2. Do not install identification products until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.7 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

A. Identification for Equipment:
1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
   a. Switchgear:
      1) Identify ampere rating.
      2) Identify voltage and phase.
      3) Identify power source and circuit number. Include location when not within sight of equipment.
      4) Use identification nameplate to identify main and tie devices.
      5) Use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.
   b. Switchboards:
      1) Identify ampere rating.
      2) Identify voltage and phase.
      3) Identify power source and circuit number. Include location when not within sight of equipment.
      4) Use identification nameplate to identify main overcurrent protective device.
      5) Use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.
   c. Panelboards:
      1) Identify ampere rating.
      2) Identify voltage and phase.
      3) Identify power source and circuit number. Include location when not within sight of equipment.
      4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
      5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces.

6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

d. Enclosed switches, circuit breakers, and motor controllers:
   1) Identify voltage and phase.
   2) Identify power source and circuit number. Include location when not within sight of equipment.
   3) Identify load(s) served. Include location when not within sight of equipment.

e. Time Switches:
   1) Identify load(s) served and associated circuits controlled. Include location.

f. Enclosed Contactors:
   1) Identify ampere rating.
   2) Identify voltage and phase.
   3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
   4) Identify coil voltage.
   5) Identify load(s) and associated circuits controlled. Include location.

g. Centralized Emergency Lighting Inverters:
   1) Identify input and output voltage and phase.
   2) Identify power source and circuit number for normal power source. Include location when not within sight of equipment.
   3) Identify load(s) served. Include location.

h. Electricity Meters:
   1) Identify load(s) metered.

2. Service Equipment:
   a. Use identification nameplate to identify each service disconnecting means.
   b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
3. Emergency System Equipment:
   a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
   b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.

c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.

4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
5. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.
6. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
7. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
8. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
9. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
10. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.
    a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches wide, painted in accordance with Section 099123 and 099113.
11. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.
    a. Service equipment.
    b. Industrial control panels.
    c. Motor control centers.
    d. Elevator control panels.
    e. Industrial machinery.
12. Arc Flash Hazard Warning Labels: Comply with Section 260573.

B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 260519.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
    a. At each source and load connection.
    b. Within boxes when more than one circuit is present.
    c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
    d. In cable tray, at maximum intervals of 20 feet.
4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
5. Use underground warning tape to identify direct buried cables.

C. Identification for Raceways:
   1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
   2. Use voltage markers, color-coded bands, or factory-painted conduits to identify systems other than normal power system for accessible conduits.
      a. Maximum Intervals: 20 feet.
      b. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
         1) Field-Painting: Comply with Section 099123 and 099113.
         2) Vinyl Color Coding Electrical Tape: Comply with Section 260519.
      c. Color Code:
         1) Emergency Power System: Red.
   3. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
   4. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
   5. Use underground warning tape to identify underground raceways.
   6. Use voltage markers to identify highest voltage present for wireways at maximum intervals of 20 feet.

D. Identification for Cable Tray: Comply with Section 260536.

E. Identification for Boxes:
   1. Use voltage markers to identify highest voltage present.
   2. Use voltage markers or color coded boxes to identify systems other than normal power system.
      a. Color-Coded Boxes: Field-painted in accordance with Section 099123 and 099113 per the same color code used for raceways.
      b. For exposed boxes in public areas, do not color code.
   3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
      a. For exposed boxes in public areas, use only identification labels.
   4. Use warning labels to identify electrical hazards for boxes containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".

F. Identification for Devices:
   1. Wiring Device and Wallplate Finishes: Comply with Section 262726.
   2. Use identification label to identify fire alarm system devices.
      a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.

3. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
    a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.
4. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

G. Identification for Luminaires:
1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

H. Identification for Photovoltaic Systems: Comply with Section 263100

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
1. Manufacturers:
    a. Brimar Industries, Inc: www.brimar.com/#sle.
    b. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
    c. Seton Identification Products: www.seton.com/#sle.
    d. Substitutions: See Section 016000 - Product Requirements.
2. Materials:
    a. Indoor Clean, Dry Locations: Use plastic nameplates.
    b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
    a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:
1. Manufacturers:
    a. Brady Corporation: www.bradyid.com/#sle.
    b. Brother International Corporation: www.brother-usa.com/#sle.
    c. Panduit Corp: www.panduit.com/#sle.
2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
    a. Use only for indoor locations.
3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:
   1. Minimum Size: 1 inch by 2.5 inches.
   2. Legend:
      a. System designation where applicable:
         1) Emergency Power System: Identify with text "EMERGENCY".
         2) Fire Alarm System: Identify with text "FIRE ALARM".
      b. Equipment designation or other approved description.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height:
      a. System Designation: 1 inch.
      b. Equipment Designation: 1/2 inch.
      c. Other Information: 1/4 inch.
   5. Color:
      a. Normal Power System: White text on black background.
      b. Emergency Power System: White text on red background.
      c. Fire Alarm System: White text on red background.

D. Format for General Information and Operating Instructions:
   1. Minimum Size: 1 inch by 2.5 inches.
   2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height: 1/4 inch.
   5. Color: Black text on white background unless otherwise indicated.

E. Format for Caution and Warning Messages:
   1. Minimum Size: 2 inches by 4 inches.
   2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height: 1/2 inch.
   5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Receptacle Identification:
   1. Minimum Size: 3/8 inch by 1.5 inches.
   2. Legend: Power source and circuit number or other designation indicated.
      a. Include voltage and phase for other than 120 V, single phase circuits.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height: 3/16 inch.
   5. Color: Black text on clear background.

G. Format for Control Device Identification:
   1. Minimum Size: 3/8 inch by 1.5 inches.
   2. Legend: Load controlled or other designation indicated.

3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

H. Format for Fire Alarm Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Red text on white background.

2.3 WIRE AND CABLE MARKERS

A. Manufacturers:
1. Brady Corporation: www.bradyid.com/#sle.
2. HellermannTyton: www.hellermanntyton.com/#sle.
3. Panduit Corp: www.panduit.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

D. Legend: Power source and circuit number or other designation indicated.

E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

F. Minimum Text Height: 1/8 inch.

G. Color: Black text on white background unless otherwise indicated.

2.4 VOLTAGE MARKERS

A. Manufacturers:
1. Brady Corporation: www.bradyid.com/#sle.
2. Brimar Industries, Inc: www.brimar.com/#sle.
3. Seton Identification Products: www.seton.com/#sle.

B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.

C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

D. Minimum Size:

1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.

E. Legend:
1. Markers for Voltage Identification: Highest voltage present.
2. Markers for System Identification:
a. Emergency Power System: Text "EMERGENCY".

F. Color: Black text on orange background unless otherwise indicated.

2.5 UNDERGROUND WARNING TAPE

A. Manufacturers:
1. Brady Corporation: www.bradyid.com/#sle.
2. Brimar Industries, Inc: www.brimar.com/#sle.
3. Seton Identification Products: www.seton.com/#sle.

B. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
1. Exception: Use foil-backed detectable type tape where required by serving utility or where directed by Owner.

C. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.

D. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.

E. Legend: Type of service, continuously repeated over full length of tape.

F. Color:
1. Tape for Buried Power Lines: Black text on red background.
2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.6 FLOOR MARKING TAPE

A. Manufacturers:
1. Brady Corporation: www.bradyid.com/#sle.
2. Brimar Industries, Inc: www.brimar.com/#sle.
3. Insite Solutions, LLC: www.stop-painting.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlaminate, 3 inches wide, with alternating black and white stripes.

2.7 WARNING SIGNS AND LABELS

A. Manufacturers:
   1. Brimar Industries, Inc: www.brimar.com/#sle.
   2. Clarion Safety Systems, LLC: www.clarionsafety.com/#sle.
   3. Insite Solutions, LLC: www.stop-painting.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

C. Warning Signs:
   1. Materials:
      a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
      b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
   2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
   3. Minimum Size: 7 by 10 inches unless otherwise indicated.

D. Warning Labels:
   1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
      a. Do not use labels designed to be completed using handwritten text.
   2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
   3. Minimum Size: 2 by 4 inches unless otherwise indicated.

E. Floor Signs:
   1. Materials: Use factory preprinted, self-adhesive vinyl, polyester, or rubber labels with protective overlaminate; removable.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

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

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   1. Surface-Mounted Equipment: Enclosure front.
   2. Flush-Mounted Equipment: Inside of equipment door.

3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
4. Elevated Equipment: Legible from the floor or working platform.
5. Branch Devices: Adjacent to device.
6. Interior Components: Legible from the point of access.
7. Conduits: Legible from the floor.
8. Boxes: Outside face of cover.
9. Conductors and Cables: Legible from the point of access.
10. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.

G. Secure rigid signs using stainless steel screws.

H. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 260553

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies, and the setting of these devices and an Arc Flash Hazard Analysis.
   1. Prepare a fault-current and coordination study and an Arc Flash Hazard Analysis for all existing and new electrical equipment and overcurrent devices to be installed under this project to assure proper equipment and personnel protection.
   2. The study shall present an organized time-current analysis of each protective device in series from the individual device back to the utility and the on-site generator sources. The study shall reflect the operation of each device during normal and abnormal current conditions.
   3. Provide study reports with Professional Engineer's seal verifying calculations. Certification shall be by a Professional Electrical Engineer with P.E. registration in the state in which the project is located. One copy is to have live seal. The remaining copies may have photocopies of the Engineer's seal.

1.3 SUBMITTALS

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

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Other Action Submittals:
   1. Coordination-study input data, including completed computer program input data sheets.
   2. Fault-current and coordination-study report.
   3. Equipment evaluation report.
   4. Setting report.
   5. Arc Flash Hazard Analysis results report.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

C. Testing Agency Qualifications: Member company of the International Electrical Testing Association.
   1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise testing specified in Part 3.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developer: Subject to compliance with requirements, provide computer software program by SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.
   1. Optional Features:
      a. Arcing faults.
      b. Simultaneous faults.
      c. Explicit negative sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.

B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.

3.2 FAULT-CURRENT STUDY

A. Source Impedance: Utility Company's fault-current contribution as provided by local utility company.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:
   1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.
   2. Low-Voltage Fuses: IEEE C37.46.
   3. Circuit Breakers: IEEE C37.13.

E. Study Report: Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system one-line diagram of the report. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase-to-ground faults.

F. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties.

3.3 3.3

3.4 COORDINATION STUDY

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical distribution system one-line diagram showing the following:
    a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment.
    b. Circuit-breaker and fuse-current ratings and types.
    c. Relays and associated power and current transformer ratings and ratios.
    d. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    e. Generator kilovolt amperes, size, voltage, and source impedance.
    f. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.
    g. Busway ampacity and impedance.
    h. Motor horsepower and code letter designation according to NEMA MG 1.
4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:
    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Magnetic inrush current overload capabilities of transformers.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Ratings, types, and settings of utility company's overcurrent protective devices.
    e. Special overcurrent protective device settings or types stipulated by utility company.
    f. Time-current-characteristic curves of devices indicated to be coordinated.
    g. Manufacturer, frame size, interrupting rating in amperes RMS symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    i. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes RMS symmetrical.

B. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.

C. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

D. Comply with IEEE 242 recommendations for fault currents and time intervals.

E. Transformer Primary Overcurrent Protective Devices:
    1. Device shall not operate in response to the following:

a. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
b. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.

F. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

G. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

H. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
a. Device tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.
2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Show the following specific information:
a. Device tag.
b. Voltage and current ratio for curves.
c. Three-phase and single-phase damage points for each transformer.
d. No damage, melting, and clearing curves for fuses.
e. Cable damage curves.
f. Transformer inrush points.
g. Maximum fault-current cutoff point.
3. Completed data sheets for setting of overcurrent protective devices.

I.

ARC FLASH HAZARD ANALYSIS STUDY

J. Provide an Arc Flash Hazard Analysis of the electrical distribution system. The Arc Flash Hazard Analysis will include the following:
1. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for project and use approved compute software program to calculate values. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
2. Perform calculations based on compliance with NEC 110.16, OSHA, NFPA 70E and IEEE 1584 standards.

3. Perform calculations of the potential incident energy that someone can be exposed to at the equipment locations during a fault event.
4. Specify hazard category to determine the proper PPE (personal protective equipment) required.
5. Specify the limited approach, restricted approach and prohibited approach boundaries for the specified hazard category.
6. Provide PDF files ready for printing of equipment labels for each equipment identifying the above information.
7. Provide printed adhesive labels to attach to each piece of equipment included in the analysis identifying the above hazard information.
8. Provide a summary table of all equipment included in the analysis.
9. Document results of the analysis in a report format, which will summarize the results of the analysis, PPE required, and define approach boundaries for all equipment analyzed.

3.5 OVERCURRENT PROTECTIVE DEVICE SETTING

A. Testing: Engage a qualified testing agency to perform the following device setting and to prepare test reports.
   1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:
      a. Verify that overcurrent protective devices meet parameters used in studies.
      b. Adjust devices to values listed in study results.
   2. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 10.7 and 10.8 in NETA ATS.

END OF SECTION 260574 260573

SECTION 260583 - WIRING CONNECTIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical connections to equipment.

1.2 RELATED REQUIREMENTS

A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables.

B. Section 260533.13 - Conduit for Electrical Systems.

C. Section 260533.16 - Boxes for Electrical Systems.

D. Section 262726 - Wiring Devices.

E. Section 262816.16 - Enclosed Switches.

F. Section 262913 - Enclosed Controllers.

1.3 REFERENCE STANDARDS

A. NEMA WD 1 - General Color Requirements for Wiring Devices 1999 (Reaffirmed 2020).

B. NEMA WD 6 - Wiring Devices - Dimensional Specifications 2021.

C. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
   2. Determine connection locations and requirements.

B. Sequencing:
   1. Install rough-in of electrical connections before installation of equipment is required.
   2. Make electrical connections before required start-up of equipment.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
   1. Colors: Comply with NEMA WD 1.
   2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
   3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

B. Disconnect Switches: As specified in Section 262816.16 and in individual equipment sections.

C. Wiring Devices: As specified in Section 262726.

D. Flexible Conduit: As specified in Section 260533.13.

E. Wire and Cable: As specified in Section 260519.

F. Boxes: As specified in Section 260533.16.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION 260583

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SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Occupancy sensors.

B. Outdoor motion sensors.

C. Time switches.

D. In-wall time switches.

E. In-wall interval timers.

F. Outdoor photo controls.

G. Daylighting controls.

H. Lighting contactors.

I. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 260529 - Hangers and Supports for Electrical Systems

B. Section 260533.16 - Boxes for Electrical Systems.

C. Section 260573 - Power System Studies.

D. Section 262726 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, and fan speed controllers.

1.3 REFERENCE STANDARDS

A. 47 CFR 15 - Radio Frequency Devices current edition.

B. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing 2017.

C. ANSI C136.24 - American National Standard for Roadway and Area Lighting Equipment - Nonlocking (Button) Type Photocontrols 2020.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

E. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2016.

F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

G. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Disharge Ballasts 2020.

H. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts 2008 (Reaffirmed 2020).

I. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices 2017.

J. NEMA ICS 6 - Industrial Control and Systems: Enclosures 1993 (Reaffirmed 2016).

K. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. UL 773 - Plug-in, Locking Type Photocontrols for Use with Area Lighting Current Edition, Including All Revisions.

M. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control Current Edition, Including All Revisions.

N. UL 916 - Energy Management Equipment Current Edition, Including All Revisions.

O. UL 917 - Clock-Operated Switches Current Edition, Including All Revisions.

P. UL 1472 - Solid-State Dimming Controls Current Edition, Including All Revisions.

Q. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules Current Edition, Including All Revisions.

R. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.
   3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.

4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
5. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

B. Sequencing:
1. Do not install lighting control devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.

C. Shop Drawings:
1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.
2. Daylighting Controls: Provide lighting plan indicating location, model number, and orientation of each photo sensor and associated system component.

D. Field Quality Control Reports.

E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Operation and Maintenance Data: Include detailed information on device programming and setup.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 016000 - Product Requirements, for additional provisions.
2. Extra Locking Receptacle-Mounted Outdoor Photo Controls: Five percent of total quantity installed for each type, but not less than two of each type.
3. Electronic Trip Circuit Breakers: Provide one portable test set.
4. Indicating Lights: Two of each different type.

H. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for all occupancy sensors.

C. Provide five year manufacturer warranty for utility grade locking receptacle-mounted outdoor photo controls.

D. Provide two year manufacturer warranty for all daylighting controls.

PART 2 PRODUCTS

2.1 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

C. Products for Switching of Electronic Ballasts/Drivers: Tested and rated to be suitable for peak inrush currents specified in NEMA 410.

2.2 OCCUPANCY SENSORS

A. Manufacturers:

1. Hubbell Incorporated: www.hubbell.com/#sle.
2. Lutron Electronics Company, Inc: www.lutron.com/#sle.
3. RAB Lighting, Inc: www.rablighting.com/#sle.
4. Sensor Switch Inc: www.sensorswitch.com/#sle.
5. WattStopper: www.wattstopper.com/#sle.
6. Substitutions: See Section 016000 - Product Requirements.
7. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. All Occupancy Sensors:
   1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
   2. Sensor Technology:
      a. Passive Infrared (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.
      b. Ultrasonic Occupancy Sensors: Designed to detect occupancy by sensing frequency shifts in emitted and reflected inaudible sound waves.
      c. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
      d. Passive Infrared/Acoustic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and audible sound sensing technologies.
   3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
   4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
   5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
   6. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
   7. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
   8. Sensitivity: Field adjustable.
   9. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
   10. Compatibility (Non-Dimming Sensors): Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
   11. Load Rating for Line Voltage Occupancy Sensors:
      a. Incandescent Load: Not less than 800 W.
      b. Fluorescent Load: Not less than 800 W at 120 V ac and 1,200 W at 277 V ac.
      c. Motor Load: Not less than 1/6 HP.

12. Isolated Relay for Low Voltage Occupancy Sensors: SPDT dry contacts, ratings as required for interface with system indicated.
13. Where wired sensors are indicated, wireless sensors are not acceptable without prior approval of Architect.
14. Wireless Sensors:
    a. RF Range: 30 feet through typical construction materials.
    b. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B application.
    c. Power: Battery-operated with minimum ten-year battery life.

C. Wall Switch Occupancy Sensors:
1. All Wall Switch Occupancy Sensors:
    a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
    b. Unless otherwise indicated or required to control the load indicated on drawings, provide line voltage units with self-contained relay.
    c. Where indicated, provide two-circuit units for control of two separate lighting loads, with separate manual controls and separately programmable operation for each load.
    d. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
    e. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
2. Passive Infrared (PIR) Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
3. Ultrasonic Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 400 square feet.
4. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.

D. Wall Dimmer Occupancy Sensors:
1. General Requirements:
    a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated dimming control capability , and no leakage current to load in off mode.
    b. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
    c. Manual-Off Override Control Capability: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
    d. Dimmer: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, and listed as complying with UL 1472; type and rating suitable for load controlled.
    e. Provide field adjustable dimming preset for occupied state.

2. Passive Infrared (PIR) Wall Dimmer Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.

E. Ceiling Mounted Occupancy Sensors:
   1. All Ceiling Mounted Occupancy Sensors:
      a. Description: Low profile occupancy sensors designed for ceiling installation.
      b. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
      c. Provide field selectable setting for disabling LED motion detector visual indicator.
      d. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
      e. Finish: White unless otherwise indicated.
   2. Passive Infrared (PIR) Ceiling Mounted Occupancy Sensors:
      a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
      b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
   3. Ultrasonic Ceiling Mounted Occupancy Sensors:
      a. Standard Range Sensors: Capable of detecting motion within an area of 500 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
      b. Medium Range Sensors: Capable of detecting motion within an area of 1,000 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
      c. Extended Range Sensors: Capable of detecting motion within an area of 2,000 square feet at a mounting height of 9 feet.
   4. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:
      a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
      b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
   5. Passive Infrared/Acoustic Dual Technology Ceiling Mounted Occupancy Sensors:
      a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
      b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet at a mounting height of 9 feet.

F. Directional Occupancy Sensors:
   1. All Directional Occupancy Sensors: Designed for wall or ceiling mounting, with integral swivel for field adjustment of motion detection coverage.
      a. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
      b. Provide field selectable setting for disabling LED motion detector visual indicator.
      c. Finish: White unless otherwise indicated.
   2. Passive Infrared (PIR) Directional Occupancy Sensors:
      a. Long Range Sensors: Capable of detecting motion within a distance of 80 feet at a mounting height of 10 feet.

b. High Bay Sensors: Capable of detecting motion within a distance of 50 feet at a mounting height of 30 feet.

3. Passive Infrared/Ultrasonic Dual Technology Directional Occupancy Sensors: Capable of detecting motion within a distance of 40 feet at a mounting height of 10 feet.

G. Luminaire Mounted Occupancy Sensors: Designed for direct luminaire installation and control, suitable for use with specified luminaires.

1. Fluorescent High Bay Luminaire Mounted Occupancy Sensors: Passive infrared (PIR) type with a field of view of 360 degrees unless otherwise indicated.
   a. Unless otherwise indicated or required to control the load indicated on drawings, provide line voltage units with self-contained relay.
   b. Finish: White unless otherwise indicated.
   c. Circular Coverage Sensors: Capable of detecting motion within a distance of 40 feet at a mounting height of 20 feet.
   d. Linear Aisle Coverage Sensors: Capable of detecting motion within an area of 20 feet wide by 60 feet long at a mounting height of 40 feet.
   e. Accessories:
      1) Provide mounting bracket for lowering occupancy sensor such that luminaire does not block sensor field of view where required.

H. Power Packs for Low Voltage Occupancy Sensors:

1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.
2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.
3. Input Supply Voltage: Dual rated for 120/277 V ac.
4. Load Rating: As required to control the load indicated on drawings.

I. Power Packs for Wireless Occupancy Sensors:

1. Description: Plenum rated, self-contained relay compatible with specified wireless occupancy sensors for switching of line voltage loads.
2. Input Supply Voltage: Dual rated for 120/277 V ac.
3. Load Rating: As required to control the load indicated on drawings.
4. Provide auxiliary contact closure output where indicated.
5. Rated Life of Relay: One million cycles.

J. Accessories:

1. Provide heavy duty coated steel wire protective guards compatible with specified occupancy sensors where indicated.

2.3 OUTDOOR MOTION SENSORS

A. Manufacturers:

1. Hubbell Lighting, Inc: www.hubbelllighting.com/#sle.
2. Lithonia Lighting: www.lithonia.com/#sle.
3. RAB Lighting, Inc: www.rablighting.com/#sle.

4. WattStopper: www.wattstopper.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.
6. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. Description: Factory-assembled wet location listed device suitable for wall or ceiling/eave mounting, with integral swivel for field adjustment of coverage, capable of detecting motion for automatic control of load indicated.

C. Sensor Technology: Passive Infrared (PIR) designed to detect occupancy by sensing movement of thermal energy between zones.

D. Operation: Unless otherwise indicated, motion sensor to turn load on when motion is detected and to turn load off when no motion is detected during an adjustable turn-off delay time interval.

E. Turn-Off Delay: Field adjustable, with time delay settings available up to 15 minutes.

F. Integral Photocell: For dusk to dawn operation.

G. Manual Override: Activated by switching power off to unit and then back on.

H. Load Rating: 1,000 W incandescent and fluorescent load at 120 V ac.

I. Coverage: Capable of detecting motion within a distance of 50 feet at a mounting height of 8 feet, with a field of view of 270 degrees.

2.4 TIME SWITCHES

A. Manufacturers:
1. Intermatic, Inc: www.intermatic.com/#sle.
2. Tork, a division of NSI Industries LLC: www.tork.com/#sle.
3. Substitutions: See Section 016000 - Product Requirements.
4. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. Digital Electronic Time Switches:
1. Description: Factory-assembled solid state programmable controller with LCD display, listed and labeled as complying with UL 916 or UL 917.
2. Program Capability:
   a. 24-Hour Time Switches: Single channel, with same schedule for each day of the week and skip-a-day feature to omit selected days.
   b. 7-Day Time Switches: Single channel, capable of different schedule for each day of the week with additional holiday schedule available to override normal schedule for selected days.

c. Astronomic Time Switches: Single channel, capable of different schedule for each day of the week with additional holiday schedule available to override normal schedule for selected days and field-configurable astronomic feature to automatically adjust for seasonal changes in sunrise and sunset times.

3. Schedule Capacity: Not less than 16 programmable on/off operations.
4. Provide automatic daylight savings time and leap year compensation.
5. Provide power outage backup to retain programming and maintain clock.
6. Manual override: Capable of overriding current schedule both permanently and temporarily until next scheduled event.
7. Provide remote photocell input with light level adjustment.
8. Input Supply Voltage: As indicated on the drawings.
9. Output Switch Configuration: As required to control the load indicated on drawings.
10. Output Switch Contact Ratings: As required to control the load indicated on drawings.
11. Provide lockable enclosure; environmental type per NEMA 250 as specified for the following installation locations:
    a. Indoor clean, dry locations: Type 1.
    b. Outdoor locations: Type 3R.
12. Provide flush-mounted unit where indicated, where mounted in public areas, or where mounted adjacent to flush-mounted equipment.

C. Electromechanical Time Switches:
1. Description: Factory-assembled controller with motor-operated timing dial mechanism and adjustable trippers for setting on/off operations, listed and labeled as complying with UL 917.
2. Program Capability:
    a. 24-Hour Time Switches: With same schedule for each day of the week and skip-a-day feature to omit selected days.
    b. 7-Day Time Switches: Capable of different schedule for each day of the week.
    c. Astronomic Time Switches: With same schedule for each day of the week and skip-a-day feature to omit selected days with automatic adjustment for seasonal changes in sunrise and sunset times.
3. Schedule Capacity:
    a. 24-Hour Time Switches: Accommodating not less than 12 pairs of selected on/off operations per day.
    b. 7-Day Time Switches: Accommodating not less than two pairs of selected on/off operations per day.
    c. Astronomic Time Switches: Capable of turning load on at sunset and off at either sunrise or selected fixed time.
4. Provide spring reserve backup to maintain clock during power outage.
5. Manual override: Capable of overriding current schedule both permanently and temporarily until next scheduled event.
6. Input Supply Voltage: As indicated on the drawings.
7. Output Switch Configuration: As required to control the load indicated on drawings.
8. Output Switch Contact Ratings: As required to control the load indicated on drawings.
9. Provide lockable enclosure; environmental type per NEMA 250 as specified for the following installation locations:

a. Indoor clean, dry locations: Type 1.
b. Outdoor locations: Type 3R.

10. Provide flush-mounted unit where indicated, where mounted in public areas, or where mounted adjacent to flush-mounted equipment.

2.5 IN-WALL TIME SWITCHES

A. Manufacturers:
1. Intermatic, Inc: www.intermatic.com/#sle.
2. Tork, a division of NSI Industries LLC: www.tork.com/#sle.
3. Substitutions: See Section 016000 - Product Requirements.
4. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. Digital Electronic In-Wall Time Switches:
1. Description: Factory-assembled solid state programmable controller with LCD display, suitable for mounting in standard wall box, and listed and labeled as complying with UL 916 or UL 917.
2. Program Capability:
a. Astronomic Time Switches: Capable of different schedule for each day of the week and field-configurable astronomic feature to automatically adjust for seasonal changes in sunrise and sunset times.
3. Schedule Capacity: Not less than 40 programmable on/off operations.
4. Provide automatic daylight savings time compensation.
5. Provide power outage backup to retain programming and maintain clock.
6. Manual override: Capable of overriding current schedule both permanently and temporarily until next scheduled event.
7. Switch Configuration: Suitable for use in either SPST or 3-way application.
8. Contact Ratings: As required to control the load indicated on drawings.

C. Electromechanical In-Wall Time Switches:
1. Description: Factory-assembled controller with motor-operated timing dial mechanism and adjustable trippers for setting on/off operations, suitable for mounting in standard wall box, and listed and labeled as complying with UL 917.
2. Program Capability: 24-hour time switch with same schedule for each day of the week.
3. Schedule Capacity: Accommodating not less than 24 selected on/off operations per day.
4. Manual override: Capable of permanently overriding current schedule.
5. Switch Configuration: SPST.
6. Contact Ratings: As required to control the load indicated on drawings.

2.6 IN-WALL INTERVAL TIMERS

A. Manufacturers:
1. Intermatic, Inc: www.intermatic.com/#sle.
2. Tork, a division of NSI Industries LLC: www.tork.com/#sle.
3. Substitutions: See Section 016000 - Product Requirements.

4. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. Digital Electronic In-Wall Interval Timers:
1. Description: Factory-assembled solid state programmable controller with LCD display, suitable for mounting in standard wall box, and listed and labeled as complying with UL 916 or UL 917.
2. Program Capability: Designed to turn load off at end of preset time interval.
3. Time Interval: Field selectable range of presets available up to 12 hours.
4. Provide field selectable audible and visual indication to warn that end of interval operation is about to turn off load.
5. Provide power outage backup to retain programming and maintain clock.
6. Manual override: Capable of both turning load off and resetting timer to original preset time interval.
7. Switch Configuration: Suitable for use in either SPST or 3-way application.
8. Contact Ratings: As required to control the load indicated on drawings.

C. Spring Wound In-Wall Interval Timers:
1. Description: Factory-assembled controller with mechanical spring wound timing mechanism requiring no electricity to operate; suitable for mounting in standard wall box; rotary control operator with matching wall plate factory marked with time interval units; listed and labeled as complying with UL 916 or UL 917.
2. Program Capability: Designed to turn load off at end of preset time interval.
3. Time Interval: User selectable from zero up to 15 minutes.
4. Manual override: Provide hold feature to disable timer for constant on operation.
5. Switch Configuration: SPST.
6. Contact Ratings: As required to control the load indicated on drawings.

2.7 OUTDOOR PHOTO CONTROLS

A. Manufacturers:
1. Intermatic, Inc: www.intermatic.com/#sle.
2. Tork, a division of NSI Industries LLC: www.tork.com/#sle.
3. Substitutions: See Section 016000 - Product Requirements.
4. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. Stem-Mounted Outdoor Photo Controls:
1. Description: Direct-wired photo control unit with threaded conduit mounting stem and field-adjustable swivel base, listed and labeled as complying with UL 773A.
2. Housing: Weatherproof, impact resistant polycarbonate.
3. Photo Sensor: Cadmium sulfide.
4. Provide external sliding shield for field adjustment of light level activation.
5. Light Level Activation: 1 to 5 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
6. Voltage: As required to control the load indicated on the drawings.

7. Failure Mode: Fails to the on position.
8. Load Rating: As required to control the load indicated on the drawings.
9. Provide accessory wall-mounting bracket where indicated or as required to complete installation.

C. Locking Receptacle-Mounted Outdoor Photo Controls
1. Description: Plug-in locking type photo control unit complying with ANSI C136.10 for mounting on a compatible receptacle, listed and labeled as complying with UL 773.
2. Housing: Weatherproof, impact resistant UV stabilized polypropylene, color to be selected.
3. Photo Sensor: Cadmium sulfide.
4. Light Level Activation: 1 to 3 footcandles turn-on and 1.5 to 1 turn-off to turn-on ratio with instant turn-on and delayed turn-off.
5. Voltage: As required to control the load indicated on the drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control the load indicated on the drawings.
8. Surge Protection: 160 joule metal oxide varistor.
9. Provide the following accessories where indicated or as required to complete installation:
   a. Receptacle: Complying with ANSI C136.10.
   b. Mounting Bracket.
   c. Shorting Cap: Suitable for replacing locking photo control to complete circuit.

D. Button Type Outdoor Photo Controls
1. Description: Direct-wired photo control unit complying with ANSI C136.24 with weatherproof gasketed wall plate where required or indicated, listed and labeled as complying with UL 773A.
2. Housing: Weather resistant polycarbonate.
3. Photo Sensor: Cadmium sulfide.
4. Light Level Activation: 1 to 3 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
5. Voltage: As required to control the load indicated on the drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control the load indicated on the drawings.

2.8 DAYLIGHTING CONTROLS

A. Manufacturers:
1. Hubbell Control Solutions; www.hubbell.com/hubbellcontrolsolutions/en/#sle.Hubbell
2. Lutron Electronics Company, Inc: www.lutron.com/#sle.
3. Sensor Switch Inc: www.sensorswitch.com/#sle.
4. WattStopper: www.wattstopper.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.
6. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. System Description: Control system consisting of photo sensors and compatible control modules and power packs, contactors, or relays as required for automatic control of load indicated according to available natural light; capable of integrating with occupancy sensors and manual override controls.

C. Daylighting Control Photo Sensors: Low voltage class 2 photo sensor units with output signal proportional to the measured light level and provision for zero or offset based signal.
   1. Sensor Type: Filtered silicon photo diode.
   2. Sensor Range:
      a. Indoor Photo Sensors: 5 to 100 footcandles.
      b. Outdoor Photo Sensors: 5 to 250 footcandles.
      c. Open Loop Photo Sensors: 3 to 6,000 footcandles.
   3. Where wired sensors are indicated, wireless sensors are not acceptable without prior approval of Architect.
   4. Wireless Daylighting Control Photo Sensors:
      a. RF Range: 30 feet through typical construction materials.
      b. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B application.
      c. Power: Battery-operated with minimum ten-year battery life.

D. Dimming Photo Sensors: Photo sensor units with integral controller compatible with specified dimming ballasts, for direct continuous dimming of up to 50 ballasts.

E. Daylighting Control Switching Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors, for switching of compatible power packs, contactors, or relays in response to changes in measured light levels according to selected settings.
   1. Operation: Unless otherwise indicated, load to be turned on when light level is below selected low set point and load to be turned off when light level is above selected high set point, with a no switching dead band between set points to prevent unwanted cycling.
   2. Input Delay: To prevent unwanted cycling due to intermittent light level fluctuations.
   3. Control Capability:
      a. Single Zone Switching Modules: Capable of controlling one programmable channel.
      b. Multi-Zone Switching Modules: Capable of controlling up to three separately programmable channels.

F. Daylighting Control Switching Modules for Wireless Sensors:
   1. Description: Plenum rated, self-contained relay compatible with specified wireless photo sensors for switching of line voltage loads in response to changes in measured light levels according to selected settings.
   2. Operation: Unless otherwise indicated, load to be turned on when light level is below selected low set point and load to be turned off when light level is above selected high set point, with a no switching dead band between set points to prevent unwanted cycling.
   3. Input Delay: To prevent unwanted cycling due to intermittent light level fluctuations.
   4. Control Capability: Capable of controlling one programmable channel.

5. Input Supply Voltage: Dual rated for 120/277 V ac.
6. Load Rating: As required to control the load indicated on drawings.
7. Provide auxiliary contact closure output where indicated.
8. Rated Life of Relay: One million cycles.

G. Daylighting Control Dimming Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors and with specified dimming ballasts, for both continuous dimming of compatible dimming ballasts and switching of compatible power packs, contactors, or relays in response to changes in measured light levels according to selected settings.
   1. Operation: Unless otherwise indicated, specified load to be continuously brightened as not enough daylight becomes available and continuously dimmed as enough daylight becomes available.
   2. Load to be turned off when available daylight is sufficient to fully dim the load, after the selected time delay.
   3. Control Capability: Capable of controlling up to three separately programmable channels, with up to 50 ballasts per channel.
   4. Dimming and Fade Rates: Adjustable from 5 to 60 seconds.
   5. Cut-Off Delay: Selectable and adjustable from 0 to 20 minutes.
   6. Output Voltage: Compatible with specified dimming ballasts.

H. Daylighting Control Dimming Modules for Wireless Sensors:
   1. Description: Plenum rated control unit compatible with specified wireless photo sensors and with specified dimming ballasts, for continuous dimming of compatible dimming ballasts in response to changes in measured light levels according to selected settings.
   2. Operation: Unless otherwise indicated, specified load to be continuously brightened as not enough daylight becomes available and continuously dimmed as enough daylight becomes available.
   3. Load to be turned off when available daylight is sufficient to fully dim the load, after the selected time delay.
   4. Control Capability: Capable of controlling up to 32 ballasts with up to two separately programmable daylighting zones.

I. Power Packs for Low Voltage Daylighting Control Modules:
   1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage daylighting control modules for switching of line voltage loads. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.
   2. Input Supply Voltage: Dual rated for 120/277 V ac.

J. Accessories:
   1. Where indicated, provide compatible accessory wall switches for manual override control.
   2. Where indicated, provide compatible accessory wireless controls for manual override control.

2.9 LIGHTING CONTACTORS

A. Manufacturers:
1. ABB/GE: www.electrification.us.abb.com/#sle.
2. Eaton Corporation: www.eaton.com/#sle.
3. Rockwell Automation Inc; Allen-Bradley Products; ab.rockwellautomation.com/#sle.
4. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
5. Siemens Industry, Inc; www.usa.siemens.com/#sle.
6. Substitutions: See Section 016000 - Product Requirements.

B. Description: Magnetic lighting contactors complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; noncombination type unless otherwise indicated; ratings, configurations and features as indicated on the drawings.

C. Combination Contactors: NEMA ICS 2, Class A combination controllers with magnetic contactor(s) and externally operable disconnect.
1. Disconnects: Circuit breaker type.
   a. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
   b. Provide auxiliary interlock for disconnection of external control power sources where applicable.

D. Short Circuit Current Rating:
1. Provide contactors with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 260573.

E. Enclosures:
1. Comply with NEMA ICS 6.
2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: Type 1 or Type 12.
   b. Outdoor Locations: Type 3R or Type 4.
3. Finish: Manufacturer's standard unless otherwise indicated.

2.10 ACCESSORIES

A. Auxiliary Contacts:
1. Comply with NEMA ICS 5.
2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each lighting contactor, minimum.

B. Pilot Devices:
1. Comply with NEMA ICS 5; heavy-duty type.

2. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
3. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
4. Indicating Lights: Push-to-test type unless otherwise indicated.
5. Provide LED lamp source for indicating lights and illuminated devices.

C. Control and Timing Relays:
1. Comply with NEMA ICS 5.
2. Provide number and type of relays indicated or required to perform necessary functions.
3. Timing Relays: Electronic or pneumatic as indicated.
a. Adjustable Timing Range: As indicated on drawings.

D. Fire-Rated Device Enclosures:
1. Manufacturers:
a. Fire Rated Product Specialties Corp: www.frpsonline.com/#sle.
2. Provide as required to preserve fire resistance rating of building elements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.

F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.

G. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 260533.16 as required for installation of lighting control devices provided under this section.
   1. Mounting Heights: Unless otherwise indicated, as follows:
      a. Wall Switch Occupancy Sensors: 48 inches above finished floor.
      b. In-Wall Time Switches: 48 inches above finished floor.
      c. In-Wall Interval Timers: 48 inches above finished floor.
   2. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.
   3. Locate wall switch occupancy sensors on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Engineer to obtain direction prior to proceeding with work.

C. Install lighting control devices in accordance with manufacturer's instructions.

D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

E. Install lighting control devices plumb and level, and held securely in place.

F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 262726.

G. Provide required supports in accordance with Section 260529.

H. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

I. Occupancy Sensor Locations:
   1. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.

J. Outdoor Photo Control Locations:
   1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
   2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by the photo control itself.

K. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into the photo control.

L. Daylighting Control Photo Sensor Locations:
   1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for proper control of respective room or area based on manufacturer's recommendations for installed devices.
   2. Unless otherwise indicated, locate photo sensors for closed loop systems to accurately measure the light level controlled at the designated task location, while minimizing the measured amount of direct light from natural or artificial sources such as windows or pendant luminaires.
   3. Unless otherwise indicated, locate photo sensors for open loop systems to accurately measure the level of daylight coming into the space, while minimizing the measured amount of lighting from artificial sources.

M. Combination Enclosed Lighting Contactors:
   1. Except where indicated to be mounted adjacent to the equipment they supply, mount lighting contactors such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

N. Lamp Burn-In: Operate lamps at full output for minimum of 100 hours or prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

O. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.

P. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.

Q. Unless otherwise indicated, install switches on load side of power packs so that switch does not turn off power pack.

R. Where indicated or required, provide cabinet or enclosure in accordance with Section 260533.16 for mounting of lighting control device system components.

3.4 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect each lighting control device for damage and defects.

C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.

D. Test time switches to verify proper operation.

E. Test outdoor photo controls to verify proper operation, including time delays where applicable.

F. Test daylighting controls to verify proper operation, including light level measurements and time delays where applicable. Record test results in written report to be included with submittals.

G. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.5 ADJUSTING

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

B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Engineer.

C. Adjust position of directional occupancy sensors and outdoor motion sensors to achieve optimal coverage as required.

D. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.

E. Adjust time switch settings to achieve desired operation schedule as indicated or as directed by Engineer. Record settings in written report to be included with submittals.

F. Adjust external sliding shields on outdoor photo controls under optimum lighting conditions to achieve desired turn-on and turn-off activation as indicated or as directed by Engineer.

G. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as indicated or as directed by Architect. Record settings in written report to be included with submittals. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Engineer.

3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.7 COMMISSIONING

A. See Section 019113 - General Commissioning Requirements for commissioning requirements.

3.8 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. See Section 017900 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of lighting control devices to Engineer, and correct deficiencies or make adjustments as directed.

D. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of two hours of training.
   3. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of the installed lighting control devices.
   4. Location: At project site.

END OF SECTION 260923

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SECTION 262100 - LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical service requirements.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Materials and installation requirements for cast-in-place concrete equipment pads.

B. Section 260526 - Grounding and Bonding for Electrical Systems.

C. Section 260529 - Hangers and Supports for Electrical Systems.

D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.3 DEFINITIONS

A. Service Point: The point of connection between the facilities of the serving utility and the premises wiring as defined in NFPA 70, and as designated by the Utility Company.

1.4 REFERENCE STANDARDS

A. IEEE C2 - National Electrical Safety Code(R) (NESC(R)) 2023.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

C. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 ADMINISTRATIVE REQUIREMENTS

A. No later than two weeks following date of the Agreement, notify Utility Company of anticipated date of service.

B. Coordination:
   1. Verify the following with Utility Company representative:
      a. Utility Company requirements, including division of responsibility.
      b. Exact location and details of utility point of connection.
      c. Utility easement requirements.
      d. Utility Company charges associated with providing service.
   2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for electrical service and associated equipment.

3. Coordinate arrangement of service entrance equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Coordinate the work with other installers to provide communication lines required for Utility Company meters.
5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

C. Arrange for Utility Company to provide permanent electrical service. Prepare and submit documentation required by Utility Company.

D. Utility Company charges associated with providing permanent service to be paid by Owner.

E. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Utility Company representative.

F. Scheduling:
1. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.
2. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.6 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Utility Company letter of availability for providing electrical service to project.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product. Include ratings, configurations, standard wiring diagrams, outline and support point dimensions, finishes, weights, service condition requirements, and installed features.

D. Shop Drawings: Include dimensioned plan views and sections indicating locations and arrangement of Utility Company and service entrance equipment, metering provisions, required clearances, and proposed service routing.
1. Obtain Utility company approval of shop drawings prior to submittal.

E. Drawings prepared by Utility Company.

F. Project Record Documents: Record actual locations of equipment and installed service routing.

1.7 QUALITY ASSURANCE

A. Comply with the following:
1. IEEE C2 (National Electrical Safety Code).
2. NFPA 70 (National Electrical Code).
3. The requirements of the Utility Company.
4. The requirements of the local authorities having jurisdiction.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

B. Store products indoors in a clean, dry space having a uniform temperature to prevent condensation (including outdoor rated products which are not weatherproof until completely and properly installed). Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle products carefully to avoid damage to internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 ELECTRICAL SERVICE REQUIREMENTS

A. Provide new electrical service consisting of all required conduits, conductors, equipment, metering provisions, supports, accessories, etc. as necessary for connection between Utility Company point of supply and service entrance equipment.

B. Electrical Service Characteristics: As indicated on drawings.

C. Utility Company: Eversource.

D. Division of Responsibility:
1. Pad-Mounted Utility Transformers:
   a. Transformer Vaults and Pads: Furnished and installed by Contractor per Utility Company requirements.
   b. Transformers: Furnished and installed by Utility Company.
   c. Transformer Grounding Provisions: Furnished and installed by Contractor per Utility Company requirements.
   d. Transformer Protective Bollards: Furnished and installed by Contractor per Utility Company requirements.
   e. Primary:
      1) Trenching and Backfilling: Provided by Contractor.
      2) Conduits: Furnished and installed by Contractor.
      3) Conductors: Furnished and installed by Utility Company.
   f. Secondary:
      1) Trenching and Backfilling: Provided by Contractor.

2) Conduits: Furnished and installed by Contractor.

3) Conductors: Furnished and installed by Contractor (Service Point at transformer).

2. Pole-Mounted Utility Transformers:
   a. Utility Poles: Furnished and installed by Utility Company.
   b. Transformers: Furnished and installed by Utility Company.
   c. Transformer Grounding Provisions: Furnished and installed by Utility Company.
   d. Primary: Furnished and installed by Utility Company.
   e. Secondary - Underground Service:
      1) Conduits: Furnished and installed by Contractor.

      2) Conductors: Furnished and installed by Contractor (Service Point at utility pole).

   f. Secondary - Overhead Service:
      1) Conduits/Service Masts: Furnished and installed by Contractor.

      2) Conductors: Furnished and installed by Contractor (Service Point at service mast).

3. Terminations at Service Point: Provided by Utility Company.
4. Metering Provisions:
   a. Meter Bases: Furnished and installed by Contractor per Utility Company requirements.
   b. Metering Transformer Cabinets: Furnished and installed by Contractor per Utility Company requirements.
   c. Metering Compartments in Service Entrance Equipment: Furnished and installed by Contractor per Utility Company requirements.
   d. Metering Transformers: Furnished and installed by Utility Company.
   e. Conduits Between Metering Transformers and Meters: Furnished and installed by Contractor per Utility Company requirements.
   f. Wiring Between Metering Transformers and Meters: Furnished and installed by Utility Company.
   g. Communications Conduits for Meters: Furnished and installed by Contractor per Utility Company requirements.

E. Products Furnished by Contractor: Comply with Utility Company requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings and configurations of service entrance equipment are consistent with the indicated requirements.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Verify and mark locations of existing underground utilities.

3.3 INSTALLATION

A. Install products in accordance with manufacturer's instructions and Utility Company requirements.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances and required maintenance access.

D. Construct cast-in-place concrete pads for utility equipment in accordance with Utility Company requirements and Section 033000.

E. Provide required protective bollards in accordance with Utility Company requirements.

F. Provide required support and attachment components in accordance with Section 260529.

G. Provide grounding and bonding for service entrance equipment in accordance with Section 260526.

H. Identify service entrance equipment, including main service disconnect(s) in accordance with Section 260553.

3.4 PROTECTION

A. Protect installed equipment from subsequent construction operations.

END OF SECTION 262100

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SECTION 262300 - LOW-VOLTAGE SWITCHGEAR

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Low-voltage (600 V and less) standard (non-arc-resistant) metal-enclosed drawout switchgear and accessories for service and distribution applications.

B. Low-voltage power circuit breakers for switchgear.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 260526 - Grounding and Bonding for Electrical Systems.

C. Section 260529 - Hangers and Supports for Electrical Systems.

D. Section 260548 - Vibration and Seismic Controls for Electrical Systems.
   1. Includes requirements for the seismic qualification of equipment specified in this section.

E. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

F. Section 260573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

G. Section 262513 - Low-Voltage Busways.

H. Section 264300 - Surge Protective Devices.

1.3 REFERENCE STANDARDS

A. ANSI C37.50 - American National Standard for Switchgear - Low Voltage AC Power Circuit Breakers Used In Enclosures - Test Procedures 2018.

B. ANSI C37.51 - American National Standard for Switchgear - Metal-Enclosed Low Voltage AC Power Circuit Breaker Switchgear Assemblies - Conformance Test Procedures 2018.

C. IEEE C37.13 - IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures 2015.

D. IEEE C37.16 - IEEE Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC (3200 V and below) Power Circuit Breakers 2009.

E. IEEE C37.17 - IEEE Standard for Trip Systems for Low-Voltage (1000 V and below) AC and General Purpose (1500 V and below) DC Power Circuit Breakers 2012.

F. IEEE C37.20.1 - IEEE Standard for Metal-Enclosed Low-Voltage (1000 Vac and Below, 3200 Vdc and Below) Power Circuit Breaker Switchgear 2015, with Amendment (2020).

G. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers 2016.

H. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

I. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

J. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.

K. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. UL 869A - Reference Standard for Service Equipment Current Edition, Including All Revisions.

M. UL 1053 - Ground-Fault Sensing and Relaying Equipment Current Edition, Including All Revisions.

N. UL 1066 - Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures Current Edition, Including All Revisions.

O. UL 1558 - Switchgear Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
   5. Notify Engineer of any conflicts with or deviations Contract Documents. Obtain direction before proceeding with work.

B. Service Entrance Switchgear:
   1. Coordinate with Utility Company to provide switchgear with suitable provisions for electrical service and utility metering, where applicable.

2. Coordinate with Owner to arrange for Utility Company required access to equipment for installation and maintenance.
3. Obtain Utility Company approval of switchgear prior to fabrication.
4. Preinstallation Meeting: Convene one week prior to commencing work of this section to review requirements with Utility Company representative.
5. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchgear, enclosures, overcurrent protective devices, and other installed components and accessories.
1. Include characteristic trip curves for each type and rating of overcurrent protective device.

C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, short-time current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of switchgear and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.
3. Include documentation demonstrating selective coordination upon request.
4. Include key-type mechanical interlock scheme with sequence of operations, as applicable.
5. Include proposed mimic bus single-line diagram arrangement.
6. Identify mounting conditions required for equipment seismic qualification.

D. Manufacturer's equipment seismic qualification certification.

E. Service Entrance Switchgear: Include documentation of Utility Company approval of switchgear.

F. Source Quality Control Test Reports: Include reports for tests designated in IEEE C37.20.1 as production tests.

G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

H. Field Quality Control Test Reports.

I. Project Record Documents: Record actual installed locations of switchgear and final equipment settings.

J. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

K. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements, for additional provisions.
2. Enclosure Keys: Two of each different key.
3. Circuit Breakers:
    a. Electronic Trip Units: Provide one portable test set.
    b. Handles Necessary for Racking of Devices: One for each electrical room containing drawout switchgear.
    c. Lifting Yokes: One of each different yoke required, for each electrical room containing drawout switchgear.
    d. Removable Covers: One for blocking each different opening size when circuit breaker is temporarily removed from its compartment.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store switchgear in accordance with manufacturer's instructions and IEEE C37.20.1.

B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchgear, which is not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully to avoid damage to switchgear internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Low-Voltage Switchgear - Basis of Design: Square D.

B. Low-Voltage Switchgear - Other Acceptable Manufacturers:
1. ABB/GE: www.electrification.us.abb.com/#sle.
2. Eaton Corporation: www.eaton.com/#sle.
3. Siemens Industry, Inc: www.usa.siemens.com/#sle.

C. Substitutions: See Section 016000 - Product Requirements.

D. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

E. Source Limitations: Furnish switchgear and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 LOW-VOLTAGE SWITCHGEAR

A. Provide switchgear assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Dead-front standard (non-arc-resistant) type metal-enclosed drawout switchgear complying with IEEE C37.20.1 and ANSI C37.51; listed and labeled as complying with UL 1558; ratings, configurations and features as indicated on the drawings.

D. Configuration:
1. Compartmentalization: Provide barriered compartments for each overcurrent protective device, distribution bus, and rear cable connection area.

E. Service Entrance Switchgear:
1. Listed and labeled as suitable for use as service equipment according to UL 869A.
2. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.
3. Comply with Utility Company requirements for electrical service.

4. Utility Metering Provisions: Provide separate barriered compartment complying with Utility Company requirements where indicated or where required by Utility Company. Include hinged sealable door and provisions for Utility Company current transformers (CTs), potential transformers (PTs), or potential taps as required.

F. Switchgear With Busway Transitions: Configured for bussed connection to busway provided in accordance with Section 262513.

G. Seismic Qualification: Provide switchgear and associated components suitable for application under the seismic design criteria specified in Section 260548 where required. Include certification of compliance with submittals.

H. Service Conditions:
1. Provide switchgear and associated components suitable for operation under the following service conditions without derating:
   a. Altitude: Less than 6,600 feet.
   b. Ambient Temperature: Between -22 degrees F and 104 degrees F.
2. Provide switchgear and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

I. Short Circuit Current Rating:
1. Provide switchgear with listed short circuit rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 260573.
2. Minimum Rating: 65,000 rms symmetrical amperes.

J. Short-Time Current (30-Cycle Withstand) Rating: Equivalent to specified short circuit current rating.

K. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

L. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.

M. Bussing: Sized in accordance with UL 1558 temperature rise requirements.
1. Main bus (horizontal cross bus) to be fully rated through full length of switchgear.
2. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
3. Provide solidly bonded equipment ground bus through full length of switchgear, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
4. Phase and Neutral Bus Material: Copper.
5. Ground Bus Material: Copper.
6. Provide insulated main bus (horizontal cross bus) and vertical section bus, with accommodations for accessible bus joints.

N. Conductor Terminations: Suitable for use with the conductors to be installed.
   1. Line Conductor Terminations:
      a. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
      b. Main and Neutral Lug Type: Mechanical.
   2. Load Conductor Terminations:
      a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
      b. Lug Type:
         1) Provide mechanical lugs unless otherwise indicated.

         2) Provide compression lugs where indicated.

O. Enclosures:
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.
   2. Finish: Manufacturer's standard unless otherwise indicated.
   3. Outdoor Enclosures:
      a. Color: Manufacturer's standard.
      b. Access Doors: Lockable, with all locks keyed alike.

P. Future Provisions:
   1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
   2. Arrange and equip through bus and ground bus to accommodate future installation of additional switchgear sections.

Q. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 264300, list switchgear as a complete assembly including surge protective device.

R. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

S. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.

T. Owner Metering:
   1. Provide microprocessor-based digital electrical metering system including all instrument transformers, wiring, and connections necessary for measurements specified.
   2. Measured Parameters:
      a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
      b. Current (Amps): For each phase and neutral.
      c. Frequency (Hz).

d. Real power (kW): For each phase, 3-phase total.
e. Reactive power (kVAR): For each phase, 3-phase total.
f. Apparent power (kVA): For each phase, 3-phase total.
g. Power factor.
h. Real energy (kWh).
i. Reactive energy (kVARh).
j. Apparent energy (kVAh).
k. Power demand: Real, reactive, and apparent.

3. Meter Accuracy: Plus/minus 1.0 percent.
4. Features:
   a. Communications Capability: Utilize Modbus communications protocol. Provide all accessories necessary for proper interface.
   b. KYZ pulse output.
   c. Adjustable demand interval.
   d. Remote monitoring capability via PC.

U. Instrument Transformers:
1. Comply with IEEE C57.13.
2. Select suitable ratio, burden, and accuracy as required for connected devices.
3. Current Transformers: Connect secondaries to shorting terminal blocks.
4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

2.3 LOW-VOLTAGE POWER CIRCUIT BREAKERS

A. Description: Quick-make, quick-break, trip-free low-voltage power circuit breakers with two-step stored energy closing mechanism; 100 percent rated; complying with IEEE C37.13, IEEE C37.16, IEEE C37.17, and ANSI C37.50; listed and labeled as complying with UL 1066; ratings, configurations, and features as indicated on the drawings.

B. Interrupting Capacity: Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated.

C. Operation:
1. Provide electrically operated circuit breakers.
2. Pad-Lock Provision: For preventing circuit breaker closing operation.

D. Construction: Drawout.
1. Allows withdrawal of circuit breaker into test and disconnected positions, with racking position indication (connected, test, disconnected, withdrawn).
2. Provide safety interlock to prevent racking of circuit breaker while in the ON position.
3. Pad-Lock Provision: For preventing circuit breaker drawout operation.

E. Trip Units: Solid state, microprocessor-based, true rms sensing.
1. Provide the following field-adjustable trip response settings:
   a. Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
   b. Long time delay.
   c. Short time pickup and delay.

d. Instantaneous pickup.
1) Include instantaneous function for feeder circuit breakers.

2) Omit instantaneous function or provide ability to turn instantaneous function off for main and tie circuit breakers.

e. Ground fault pickup and delay where ground fault protection is indicated.

2. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
3. Provide communication capability where indicated: Compatible with system indicated.

F. Provide the following features and accessories where indicated or where required to complete installation:
1. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
2. Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
3. Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
4. Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.
5. Truck-Operated Cell Switch: For indicating circuit breaker racking position.

2.4 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Factory test switchgear according to IEEE C37.20.1, including the following production tests on each switchgear assembly or component:
1. Dielectric tests.
2. Mechanical operation tests.
3. Grounding of instrument transformer cases test.
4. Electrical operation and control wiring tests, including polarity and sequence tests.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the switchgear and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive switchgear.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install switchgear in accordance with NECA 1 (general workmanship) and IEEE C37.20.1.

C. Arrange equipment to provide required clearances and maintenance access, including accommodations for drawout circuit breakers.

D. Provide required support and attachment in accordance with Section 260529.

E. Provide required seismic controls in accordance with Section 260548.

F. Install switchgear plumb and level.

G. Unless otherwise indicated, mount switchgear on properly sized 4 inch high concrete pad constructed in accordance with Section 033000.

H. Provide grounding and bonding in accordance with Section 260526.

I. Install all field-installed devices, components, and accessories.

J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

K. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 260573.

L. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

M. Identify switchgear in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.

C. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Before energizing switchgear, perform preoperation checks in accordance with IEEE C37.20.1.

E. Inspect and test in accordance with NETA ATS, except Section 4.

F. Perform inspections and tests listed in NETA ATS, Section 7.1.

G. Low-Voltage Power Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.2 for all main circuit breakers. Tests listed as optional are not required.

H. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
   1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

I. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.

J. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.

K. Test shunt trips to verify proper operation.

L. Correct deficiencies and replace damaged or defective switchgear assemblies or associated components.

M. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of switchgear covers and doors.

3.5 CLEANING

A. Clean dirt and debris from switchgear enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred surfaces to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. See Section 017900 - Demonstration and Training, for additional requirements.

3.7 PROTECTION

A. Protect installed switchgear assemblies from subsequent construction operations.

END OF SECTION 262300

SECTION 262413 - SWITCHBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.

B. Overcurrent protective devices for switchboards.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 260526 - Grounding and Bonding for Electrical Systems.

C. Section 260529 - Hangers and Supports for Electrical Systems.

D. Section 260548 - Vibration and Seismic Controls for Electrical Systems.
   1. Includes requirements for the seismic qualification of equipment specified in this section.

E. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

F. Section 260573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

G. Section 262513 - Low-Voltage Busways.

H. Section 262813 - Fuses: Fuses for fusible switches.
   1. Includes requirements for spare fuses and spare fuse cabinets.

I. Section 264300 - Surge Protective Devices.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service 2013e (Amended 2017).

B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers 2016.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

D. NECA 400 - Standard for Installing and Maintaining Switchboards 2007.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

F. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum) 2013.

G. NEMA PB 2 - Deadfront Distribution Switchboards 2011.

H. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less 2013.

I. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.

J. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. UL 98 - Enclosed and Dead-Front Switches Current Edition, Including All Revisions.

L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures Current Edition, Including All Revisions.

M. UL 869A - Reference Standard for Service Equipment Current Edition, Including All Revisions.

N. UL 891 - Switchboards Current Edition, Including All Revisions.

O. UL 977 - Fused Power-Circuit Devices Current Edition, Including All Revisions.

P. UL 1053 - Ground-Fault Sensing and Relaying Equipment Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
   5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Service Entrance Switchboards:
   1. Coordinate with Utility Company to provide switchboards with suitable provisions for electrical service and utility metering, where applicable.

2. Coordinate with Owner to arrange for Utility Company required access to equipment for installation and maintenance.
3. Obtain Utility Company approval of switchboard prior to fabrication.
4. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.
1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.

C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of switchboards and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.
3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
4. Include documentation of listed series ratings upon request.
5. Include documentation demonstrating selective coordination upon request.
6. Identify mounting conditions required for equipment seismic qualification.

D. Manufacturer's equipment seismic qualification certification.

E. Service Entrance Switchboards: Include documentation of Utility Company approval of switchboard.

F. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 2 as production (routine) tests.

G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

H. Field Quality Control Test Reports.

I. Project Record Documents: Record actual installed locations of switchboards and final equipment settings.

J. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

K. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements, for additional provisions.
2. Enclosure Keys: Two of each different key.
3. Electronic Trip Circuit Breakers: Provide one portable test set.
4. See Section 262813 for requirements for spare fuses and spare fuse cabinets.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.

B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Switchboards - Basis of Design: Square D.

B. Switchboards - Other Acceptable Manufacturers:
1. ABB/GE: www.electrification.us.abb.com/#sle.
2. Eaton Corporation: www.eaton.com/#sle.
3. Siemens Industry, Inc: www.usa.siemens.com/#sle.

C. Substitutions: See Section 016000 - Product Requirements.

D. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

E. Source Limitations: Furnish switchboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 SWITCHBOARDS

A. Provide switchboards consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.

D. Service Entrance Switchboards:
1. Listed and labeled as suitable for use as service equipment according to UL 869A.
2. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.
3. Comply with Utility Company requirements for electrical service.
4. Utility Metering Provisions: Provide separate barriered compartment complying with Utility Company requirements where indicated or where required by Utility Company. Include hinged sealable door and provisions for Utility Company current transformers (CTs), potential transformers (PTs), or potential taps as required.

E. Switchboards With Busway Transitions: Configured for bussed connection to busway provided in accordance with Section 262513.

F. Seismic Qualification: Provide switchboards and associated components suitable for application under the seismic design criteria specified in Section 260548 where required. Include certification of compliance with submittals.

G. Service Conditions:
1. Provide switchboards and associated components suitable for operation under the following service conditions without derating:
   a. Altitude: Less than 6,600 feet.
   b. Ambient Temperature:
      1) Switchboards Containing Molded Case or Insulated Case Circuit Breakers: Between 23 degrees F and 104 degrees F.

2) Switchboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.

2. Provide switchboards and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

H. Short Circuit Current Rating:
1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 260573.
2. Minimum Rating: 65,000 rms symmetrical amperes.

I. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

J. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.

K. Bussing: Sized in accordance with UL 891 temperature rise requirements.
1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.
2. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
3. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
4. Phase and Neutral Bus Material: Aluminum.
5. Ground Bus Material: Aluminum.

L. Conductor Terminations: Suitable for use with the conductors to be installed.
1. Line Conductor Terminations:
a. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
b. Main and Neutral Lug Type: Mechanical.
2. Load Conductor Terminations:
a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
b. Lug Type:
1) Provide mechanical lugs unless otherwise indicated.

2) Provide compression lugs where indicated.

M. Enclosures:
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
a. Indoor Clean, Dry Locations: Type 1 or Type 2 (drip-proof).
b. Outdoor Locations: Type 3R.
2. Finish: Manufacturer's standard unless otherwise indicated.

3. Outdoor Enclosures:
    a. Color: Manufacturer's standard.
    b. Access Doors: Lockable, with all locks keyed alike.

N. Future Provisions:
1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
2. Equip distribution sections with full height vertical bussing to accommodate maximum utilization of space for devices.
3. Arrange and equip through bus and ground bus to accommodate future installation of additional switchboard sections.

O. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 264300, list switchboards as a complete assembly including surge protective device.

P. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
1. Where overcurrent protective devices equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
    a. Use zero sequence or residual ground fault detection method unless otherwise indicated.
    b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
    c. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control ground fault delay functions for system coordination purposes.

Q. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.

R. Owner Metering:
1. Provide microprocessor-based digital electrical metering system including all instrument transformers, wiring, and connections necessary for measurements specified.
2. Measured Parameters:
    a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
    b. Current (Amps): For each phase and neutral.
    c. Frequency (Hz).
    d. Real power (kW): For each phase, 3-phase total.
    e. Reactive power (kVAR): For each phase, 3-phase total.
    f. Apparent power (kVA): For each phase, 3-phase total.
    g. Power factor.
    h. Real energy (kWh).

i. Apparent energy (kVAh).
j. Current demand.
k. Power demand: Real, reactive, and apparent.

3. Meter Accuracy: Plus/minus 1.0 percent.
4. Features:
   a. Communications Capability: Utilize Modbus communications protocol. Provide all accessories necessary for proper interface.
   b. KYZ pulse output.
   c. Adjustable demand interval.
   d. Remote monitoring capability via PC.

S. Instrument Transformers:
1. Comply with IEEE C57.13.
2. Select suitable ratio, burden, and accuracy as required for connected devices.
3. Current Transformers: Connect secondaries to shorting terminal blocks.
4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

2.3 OVERCURRENT PROTECTIVE DEVICES

A. Fusible Devices:
1. Fusible Switches:
   a. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA KS 1, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
   b. Fuse Clips: As required to accept indicated fuses.
      1) Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

   c. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
2. Fused Power-Circuit Devices:
   a. Description: Quick-make, quick-break, dead-front bolted-pressure contact switches and high-pressure butt contact switches listed and labeled as complying with UL 977; ratings, configurations, and features as indicated on the drawings.
   b. Bolted-Pressure Contact Switches: Devices with additional pressure or clamping action provided at both ends of switch blades when blades are in the fully closed position.
   c. High-Pressure Butt Contact Switches: Devices with butt-type contacts and spring-charged mechanism.
   d. Minimum Short Circuit Current Rating: 200,000 rms symmetrical amperes when protected by Class L fuses.
   e. Fuse Clips: As required to accept Class L fuses.

f. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
g. Provide the following features and accessories where indicated or where required to complete installation:
    1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
    2) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating switch position.
    3) Blown fuse protection and indication.

B. Circuit Breakers:
1. Interrupting Capacity:
    a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
    b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
2. Molded Case Circuit Breakers:
    a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
        1) Provide thermal magnetic circuit breakers for circuit breaker frame sizes less than 225 amperes.
        2) Provide electronic trip circuit breakers where indicated.
    b. Minimum Interrupting Capacity:
        1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
        2) 14,000 rms symmetrical amperes at 480 VAC.
    c. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
        1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
        2) Provide interchangeable trip units where indicated.
    d. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
        1) Provide the following field-adjustable trip response settings:

(a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.

(b) Long time delay.

(c) Short time pickup and delay.

(d) Instantaneous pickup.

(e) Ground fault pickup and delay where ground fault protection is indicated.

2) Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.

3) Provide communication capability where indicated: Compatible with system indicated.

e. Provide the following circuit breaker types where indicated:
1) 100 Percent Rated Circuit Breakers: Listed for application within the switchboard where installed at 100 percent of the continuous current rating.

2) Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.

f. Provide the following features and accessories where indicated or where required to complete installation:
1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

2) Pad-Lock Provision: For locking circuit breaker handle in OFF position.

3) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.

4) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.

5) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

3. Insulated Case Circuit Breakers:
a. Description: Quick-make, quick-break, trip-free circuit breakers with two-step stored energy closing mechanism; standard 80 percent rated unless otherwise indicated; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.
b. Operation:

1) Provide electrically operated circuit breakers where indicated.

2) Pad-Lock Provision: For preventing circuit breaker closing operation.

c. Construction:
   1) Provide fixed-mount circuit breakers unless otherwise indicated.

d. Minimum Interrupting Capacity:
   1) 42,000 rms symmetrical amperes at 240 VAC or 208 VAC.

   2) 65,000 rms symmetrical amperes at 480 VAC.

e. Trip Units: Solid state, microprocessor-based, true rms sensing.
   1) Provide the following field-adjustable trip response settings:

      (a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.

      (b) Long time delay.

      (c) Short time pickup and delay.

      (d) Instantaneous pickup.

      (e) Ground fault pickup and delay where ground fault protection is indicated.

   2) Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.

   3) Provide communication capability where indicated: Compatible with system indicated.

f. Provide the following circuit breaker types where indicated:
g. Provide the following features and accessories where indicated or where required to complete installation:
   1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

   2) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.

   3) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.

   4) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

2.4 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Factory test switchboards according to NEMA PB 2, including the following production (routine) tests on each switchboard assembly or component:
   1. Dielectric tests.
   2. Mechanical operation tests.
   3. Grounding of instrument transformer cases test.
   4. Electrical operation and control wiring tests, including polarity and sequence tests.
   5. Ground-fault sensing equipment test.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive switchboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.

C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.

D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 1/2 inch between switchboard and wall.

E. Provide required support and attachment in accordance with Section 260529.

F. Install switchboards plumb and level.

G. Unless otherwise indicated, mount switchboards on properly sized 4 inch high concrete pad constructed in accordance with Section 033000.

H. Provide grounding and bonding in accordance with Section 260526.

I. Install all field-installed devices, components, and accessories.

J. Provide fuses complying with Section 262813 for fusible switches as indicated.

K. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

L. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 260573.

M. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

N. Provide filler plates to cover unused spaces in switchboards.

O. Identify switchboards in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.

C. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Before energizing switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.

E. Inspect and test in accordance with NETA ATS, except Section 4.

F. Perform inspections and tests listed in NETA ATS, Section 7.1.

G. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

H. Molded Case and Insulated Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers. Tests listed as optional are not required.

I. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
   1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

J. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.

K. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.

L. Test shunt trips to verify proper operation.

M. Correct deficiencies and replace damaged or defective switchboards or associated components.

N. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of switchboard covers and doors.

3.5 CLEANING

A. See Section 017419 - Construction Waste Management and Disposal, for additional requirements.

B. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.

C. Repair scratched or marred surfaces to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. See Section 017900 - Demonstration and Training, for additional requirements.

3.7 PROTECTION

A. Protect installed switchboards from subsequent construction operations.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Power distribution panelboards.

B. Lighting and appliance panelboards.

C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 260526 - Grounding and Bonding for Electrical Systems.

C. Section 260529 - Hangers and Supports for Electrical Systems.

D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 260573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

F. Section 262813 - Fuses: Fuses for fusible switches and spare fuse cabinets.

G. Section 264300 - Surge Protective Devices.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service 2013e (Amended 2017).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

C. NECA 407 - Standard for Installing and Maintaining Panelboards 2015.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

E. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts 2008 (Reaffirmed 2020).

F. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum) 2013.

G. NEMA PB 1 - Panelboards 2011.

H. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less 2013.

I. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.

J. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.

L. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.

M. UL 67 - Panelboards Current Edition, Including All Revisions.

N. UL 98 - Enclosed and Dead-Front Switches Current Edition, Including All Revisions.

O. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures Current Edition, Including All Revisions.

P. UL 869A - Reference Standard for Service Equipment Current Edition, Including All Revisions.

Q. UL 943 - Ground-Fault Circuit-Interrupters Current Edition, Including All Revisions.

R. UL 1053 - Ground-Fault Sensing and Relaying Equipment Current Edition, Including All Revisions.

S. UL 1699 - Arc-Fault Circuit-Interrupters Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
   4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
   1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
   2. Include wiring diagrams showing all factory and field connections.
   3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
   4. Include documentation of listed series ratings upon request.
   5. Identify mounting conditions required for equipment seismic qualification.

D. Manufacturer's equipment seismic qualification certification.

E. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 1 as routine tests.

F. Field Quality Control Test Reports.

G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

H. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

I. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.
   2. Panelboard Keys: Two of each different key.
   3. See Section 262813 for requirements for spare fuses and spare fuse cabinets.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:
   1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
   2. Panelboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB/GE: www.electrification.us.abb.com/#sle.

B. Eaton Corporation: www.eaton.com/#sle.

C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

D. Siemens Industry, Inc: www.usa.siemens.com/#sle.

E. Substitutions: See Section 016000 - Product Requirements.

F. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature:
      a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
      b. Panelboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.

C. Short Circuit Current Rating:
   1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 260573.

D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
   1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
   2. Provide 200 percent rated neutral bus and lugs where indicated, where oversized neutral conductors are provided, or where panelboards are fed from K-rated transformers.
   3. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
   4. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.

H. Conductor Terminations: Suitable for use with the conductors to be installed.

I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.
   2. Boxes: Galvanized steel unless otherwise indicated.
      a. Provide wiring gutters sized to accommodate the conductors to be installed.
      b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.

c. Provide removable end walls for NEMA Type 1 enclosures.
d. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.

3. Fronts:
   a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
   b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
   c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
4. Lockable Doors: All locks keyed alike unless otherwise indicated.

J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

K. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 264300, list and label panelboards as a complete assembly including surge protective device.

L. Panelboard Contactors: Where panelboard contactors are indicated, provide electrically operated, mechanically held magnetic contactor complying with NEMA ICS 2.
1. Ampere Rating: Not less than ampere rating of panelboard bus.
2. Short Circuit Current Rating: Not less than the panelboard short circuit current rating.
3. Coil Voltage: As required for connection to control system indicated.

M. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
   a. Use zero sequence ground fault detection method unless otherwise indicated.
   b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
   c. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control ground fault delay functions for system coordination purposes.

N. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

O. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.

P. Load centers are not acceptable.

Q. Provide the following features and accessories where indicated or where required to complete installation:

1. Feed-through lugs.
2. Sub-feed lugs.

2.3 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
1. Phase and Neutral Bus Material: Aluminum.
2. Ground Bus Material: Aluminum.

D. Circuit Breakers:
1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
2. Provide thermal magnetic circuit breakers for circuit breaker frame sizes less than 225 amperes.
3. Provide electronic trip circuit breakers where indicated.

E. Enclosures:
1. Provide surface-mounted enclosures unless otherwise indicated.
2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
2. Phase and Neutral Bus Material: Aluminum.
3. Ground Bus Material: Aluminum.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:
1. Provide surface-mounted or flush-mounted enclosures as indicated.
2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

F. Provide column-width panelboards with accessory column-width cable trough and pullbox where indicated.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Fusible Switches:
1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA KS 1, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
2. Fuse Clips: As required to accept indicated fuses.
   a. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
3. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
4. Conductor Terminations:
   a. Provide mechanical lugs unless otherwise indicated.
   b. Provide compression lugs where indicated.
   c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

B. Molded Case Circuit Breakers:
1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. Interrupting Capacity:
   a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
      1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
      2) 14,000 rms symmetrical amperes at 480 VAC.
   b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
3. Conductor Terminations:
   a. Provide mechanical lugs unless otherwise indicated.
   b. Provide compression lugs where indicated.

c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
   b. Provide interchangeable trip units where indicated.
5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
   a. Provide the following field-adjustable trip response settings:
      1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
      2) Long time delay.
      3) Short time pickup and delay.
      4) Instantaneous pickup.
      5) Ground fault pickup and delay where ground fault protection is indicated.
   b. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
7. Provide the following circuit breaker types where indicated:
   a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
   b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
   c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.
   d. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.
   e. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.
8. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.
9. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.
10. Do not use tandem circuit breakers.
11. Do not use handle ties in lieu of multi-pole circuit breakers.
12. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.
13. Provide the following features and accessories where indicated or where required to complete installation:

a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.
c. Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
d. Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
e. Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

2.6 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive panelboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

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

C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

E. Provide required support and attachment in accordance with Section 260529.

F. Install panelboards plumb.

G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.

I. Mount floor-mounted power distribution panelboards on properly sized 4 inch high concrete pad constructed in accordance with Section 033000.

J. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.

K. Provide grounding and bonding in accordance with Section 260526.
   1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
   2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.

L. Install all field-installed branch devices, components, and accessories.

M. Provide fuses complying with Section 262813 for fusible switches as indicated.

N. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

O. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.

P. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 260573.

Q. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

R. Provide filler plates to cover unused spaces in panelboards.

S. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
   1. Emergency and night lighting circuits.
   2. Fire detection and alarm circuits.
   3. Communications equipment circuits.
   4. Intrusion detection and access control system circuits.
   5. Video surveillance system circuits.

T. Identify panelboards in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers. Tests listed as optional are not required.

E. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

F. Test GFCI circuit breakers to verify proper operation.

G. Test AFCI circuit breakers to verify proper operation.

H. Test shunt trips to verify proper operation.

I. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard fronts.

C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 10 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.5 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 262416

SECTION 262713 - ELECTRICITY METERING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Equipment for Owner electricity metering:
   1. Single circuit electricity meters.
   2. Multi-circuit electricity meters.

1.2 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 260529 - Hangers and Supports for Electrical Systems.

C. Section 260533.16 - Boxes for Electrical Systems: Cabinets and enclosures for metering system components.

D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 262813 - Fuses.
   1. Includes requirements for spare fuses and spare fuse cabinets.

1.3 REFERENCE STANDARDS

A. ANSI C12.1 - Electric Meters - Code for Electricity Metering 2022.

B. IEC 62053-21 - Electricity Metering Equipment - Particular Requirements - Part 21: Static Meters for AC Active Energy (Classes 0,5, 1 and 2) 2020.

C. IEC 62053-23 - Electricity Metering Equipment - Particular Requirements - Part 23: Static Meters for Reactive Energy (Classes 2 and 3) 2020.

D. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers 2016.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

G. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.

H. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate work to provide equipment suitable for interface with electricity metering systems to be provided.
   2. Coordinate the work with other installers to provide communication lines required for electricity metering system interface.
   3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Conduct meeting with facility representative and other related equipment manufacturers to discuss electricity metering system interface requirements.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for electricity metering systems and associated components and accessories. Include ratings, configurations, standard wiring diagrams, dimensions, service condition requirements, and installed features.

C. Shop Drawings: Include system interconnection schematic diagrams showing all factory and field connections. Include requirements for interface with other systems.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Field Quality Control Test Reports.

F. Project Record Documents: Record actual installed locations of meters and final equipment settings.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.
   2. Enclosure Keys: Two of each different key.
   3. See Section 262813 for requirements for spare fuses and spare fuse cabinets.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Electricity Meters - Other Acceptable Manufacturers:
1. Same as manufacturer of electrical distribution equipment used for this project.
a. ABB/GE: www.electrification.us.abb.com/#sle.
b. Eaton Corporation: www.eaton.com/#sle.
c. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
d. Siemens Industry, Inc: www.usa.siemens.com/#sle.

B. Substitutions: See Section 016000 - Product Requirements.

C. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

D. Source Limitations: Furnish electricity meters produced by a single manufacturer and obtained from a single supplier.

2.2 EQUIPMENT FOR OWNER ELECTRICITY METERING

A. Provide microprocessor-based digital electricity metering systems including all instrument transformers, wiring, and connections necessary for measurements specified.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Provide electricity metering systems and associated components compatible with the equipment and associated circuits to be metered.

D. Service Conditions: Provide electricity meters suitable for operation under the service conditions at the installed location.

E. Enclosures:
1. Where not furnished by manufacturer, provide required cabinets and enclosures in accordance with Section 260533.16.
2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
a. Indoor Clean, Dry Locations: Type 1.
b. Outdoor Locations: Type 3R or Type 4.
3. Finish: Manufacturer's standard unless otherwise indicated.

F. Instrument Transformers:
1. Comply with IEEE C57.13, where applicable.
2. Select suitable ratio, burden, and accuracy as required for connected devices.
3. Current Transformers: Compatible with connected meters; replace meters damaged by connection of incompatible current transformers. Provide shorting terminal blocks for connection of secondaries where applicable.
4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

G. Interface with Other Work:
1. Interface with electrical power monitoring system.
2. Interface with building automation system.

2.3 SINGLE CIRCUIT ELECTRICITY METERS

A. Single Circuit Electricity Meter:
1. Accuracy:
a. Real/Active Power/Energy: Revenue grade; plus/minus 1.0 percent; complying with ANSI C12.1 and/or IEC 62053-21 Class 1.
b. Reactive Power/Energy: Plus/minus 2.0 percent, complying with IEC 62053-23 Class 2.
2. Measured Parameters:
a. Voltage (Volts AC); line-to-line and line-to-neutral; per phase.
b. Current (Amps); per phase.
c. Frequency (Hz).
d. Real/active power (kW); per phase and total of all phases.
e. Reactive power (kVAR); per phase and total of all phases.
f. Apparent power (kVA); per phase and total of all phases.
g. Power factor; per phase and total of all phases.
h. Real/active energy (kWh).
i. Reactive energy (kVARh).
j. Apparent energy (kVAh).

k. Power demand; real/active, reactive, and apparent; present and maximum.
l. Current demand.
m. Bi-directional energy measurements; real/active and reactive; imported and exported.

3. Data logging.
   a. Storage Capacity: 90 days of readings at 15 minute intervals.
4. Inputs:
   a. Pulse Contact Accumulator Input(s): Two; user-configurable to support measurement of other related energy values (gas, water, steam, etc.) using pulse-output transducers.
5. Outputs:
   a. Pulse Output(s): One.
6. Communications: Compatible with connected systems. Provide all accessories necessary for proper interface.
   a. Serial Communications: RS-485; support for Modbus RTU protocol.
   b. Ethernet Communications: Support for Modbus TCP protocol.

2.4 MULTI-CIRCUIT ELECTRICITY METERS

A. Multi-Circuit Electricity Meter:
1. Metering Capacity: As indicated or as required for circuits to be metered.
2. Accuracy:
   a. Real/Active Power/Energy: Revenue grade; plus/minus 1.0 percent; complying with ANSI C12.1 and/or IEC 62053-21 Class 1.
   b. Reactive Power/Energy: Plus/minus 2.0 percent, complying with IEC 62053-23 Class 2.
3. Measured Parameters:
   a. Voltage (Volts AC); line-to-line and line-to-neutral; per phase.
   b. Current (Amps); per phase.
   c. Frequency (Hz).
   d. Real/active power (kW); per phase and total of all phases.
   e. Reactive power (kVAR); per phase and total of all phases.
   f. Apparent power (kVA); per phase and total of all phases.
   g. Power factor; per phase and total of all phases.
   h. Real/active energy (kWh).
   i. Reactive energy (kVARh).
   j. Apparent energy (kVAh).
   k. Power demand; real/active; present and maximum.
4. Data logging.
   a. Storage Capacity: 90 days of readings at 15 minute intervals.
5. Inputs:
   a. Pulse Contact Accumulator Input(s): Two; user-configurable to support measurement of other related energy values (gas, water, steam, etc.) using pulse-output transducers.
6. Outputs:
   a. Pulse Output(s): One.
7. Communications: Compatible with connected systems. Provide all accessories necessary for proper interface.
   a. Serial Communications: RS-485; support for Modbus RTU protocol.

b. Ethernet Communications: Support for Modbus TCP protocol.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of metering systems and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive meters.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

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

C. Provide required support and attachment components in accordance with Section 260529.

D. Provide grounding and bonding in accordance with Section 260526.

E. Provide fuses complying with Section 262813 as required.

F. Identify meters and associated wiring in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.

D. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.

E. Correct deficiencies and replace damaged or defective metering system components.

F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.4 ADJUSTING

A. Program system parameters according to requirements of Owner.

3.5 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. See Section 017900 - Demonstration and Training, for additional requirements.

C. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of two hours of training.
   3. Instructor: Manufacturer's authorized representative.
   4. Location: At project site.

3.7 PROTECTION

A. Protect installed system components from subsequent construction operations.

END OF SECTION 262713

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SECTION 262717 - EQUIPMENT WIRING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical connections to equipment.

1.2 RELATED REQUIREMENTS

A. Section 260533.13 - Conduit for Electrical Systems.

B. Section 260519 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).

C. Section 260533.16 - Boxes for Electrical Systems.

D. Section 262726 - Wiring Devices.

E. Section 262816.16 - Enclosed Switches.

1.3 REFERENCE STANDARDS

A. NEMA WD 1 - General Color Requirements for Wiring Devices 1999 (Reaffirmed 2020).

B. NEMA WD 6 - Wiring Devices - Dimensional Specifications 2021.

C. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
   2. Determine connection locations and requirements.

B. Sequencing:
   1. Install rough-in of electrical connections before installation of equipment is required.
   2. Make electrical connections before required start-up of equipment.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
   1. Colors: Conform to NEMA WD 1.
   2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
   3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

B. Disconnect Switches: As specified in Section 262818 and in individual equipment sections.

C. Wiring Devices: As specified in Section 262726.

D. Flexible Conduit: As specified in Section 260533.13.

E. Wire and Cable: As specified in Section 260519.

F. Boxes: As specified in Section 260533.16.

2.2 EQUIPMENT CONNECTIONS

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION 262717

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SECTION 262726 - WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wall switches.

B. Wall dimmers.

C. Fan speed controllers.

D. Receptacles.

E. Wall plates.

F. Floor box service fittings.

G. Poke-through assemblies.

H. Access floor boxes.

1.2 RELATED REQUIREMENTS

A. Section 096900 - Access Flooring.

B. Section 260533.16 - Boxes for Electrical Systems.

C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 271000 - Structured Cabling: Voice and data jacks.

1.3 REFERENCE STANDARDS

A. FS W-C-596 - Connector, Electrical, Power, General Specification for 2014h, with Amendments (2017).

B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification) 2014g, with Amendment (2017).

C. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

D. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2016.

E. NEMA WD 1 - General Color Requirements for Wiring Devices 1999 (Reaffirmed 2020).

F. NEMA WD 6 - Wiring Devices - Dimensional Specifications 2021.

G. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL 20 - General-Use Snap Switches Current Edition, Including All Revisions.

I. UL 498 - Attachment Plugs and Receptacles Current Edition, Including All Revisions.

J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices Current Edition, Including All Revisions.

K. UL 943 - Ground-Fault Circuit-Interrupters Current Edition, Including All Revisions.

L. UL 1310 - Class 2 Power Units Current Edition, Including All Revisions.

M. UL 1449 - Standard for Surge Protective Devices Current Edition, Including All Revisions.

N. UL 1472 - Solid-State Dimming Controls Current Edition, Including All Revisions.

O. UL 1917 - Solid-State Fan Speed Controls Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
5. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
6. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

B. Sequencing:
1. Do not install wiring devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1. Wall Dimmers: Include derating information for ganged multiple devices.
2. Surge Protection Receptacles: Include surge current rating, voltage protection rating (VPR) for each protection mode, and diagnostics information.

C. Samples: One for each type and color of device and wall plate specified.

D. Certificates for Surge Protection Receptacles: Manufacturer's documentation of listing for compliance with UL 1449.

E. Field Quality Control Test Reports.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data:
1. Wall Dimmers: Include information on operation and setting of presets.
2. GFCI Receptacles: Include information on status indicators.
3. Surge Protection Receptacles: Include information on status indicators.

H. Project Record Documents: Record actual installed locations of wiring devices.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 016000 - Product Requirements, for additional provisions.
2. Screwdrivers for Tamper-Resistant Screws: Two for each type of screw.
3. Extra Keys for Locking Switches: Two of each type.
4. Extra Surge Protection Receptacles: Two of each type.
5. Extra Wall Plates: One of each style, size, and finish.
6. Extra Flush Floor Service Fittings: Two of each type.
7. Extra Poke-Through Core Hole Closure Plugs: Two for each core size.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Products: Listed, classified, and labeled as suitable for the purpose intended.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.1 WIRING DEVICE APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.

B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.

C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.

D. Provide GFCI protection for receptacles installed within 6 feet of sinks.

E. Provide GFCI protection for receptacles installed in kitchens.

F. Provide GFCI protection for receptacles serving electric drinking fountains.

G. Provide isolated ground receptacles for receptacles serving computers and electronic cash registers.

H. Unless noted otherwise, do not use combination switch/receptacle devices.

I. For flush floor service fittings, use tile rings for installations in tile floors.

J. For flush floor service fittings, use carpet flanges for installations in carpeted floors.

2.2 WIRING DEVICE FINISHES

A. Provide wiring device finishes as described below unless otherwise indicated.

B. Wiring Devices, Unless Otherwise Indicated: White with white nylon wall plate.

C. Wiring Devices Installed in Finished Spaces: White with white nylon wall plate.

D. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.

E. Wiring Devices Installed in Wet or Damp Locations: White with specified weatherproof cover.

F. Isolated Ground Convenience Receptacles: Orange.

G. Surge Protection Receptacles: Blue.

H. Wiring Devices Connected to Emergency Power: Red with red nylon wall plate.

I. Clock Hanger Receptacles: Brown with stainless steel wall plate.

J. Above-Floor Service Fittings: Gray wiring devices with satin aluminum housing.

K. Flush Floor Box Service Fittings: Gray wiring devices with aluminum cover and ring/flange.

L. Flush Poke-Through Service Fittings: Gray wiring devices with aluminum cover and aluminum flange.

M. Access Floor Boxes: Gray wiring devices with gray steel cover with insert to match floor covering.

2.3 WALL SWITCHES

A. Manufacturers:
1. Hubbell Incorporated: www.hubbell.com/#sle.
2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

D. Lighted Wall Switches: Industrial specification grade, 20 A, 120/277 V with illuminated standard toggle type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

E. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

F. Locking Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

G. Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with toggle type three position switch actuator and momentary contacts; single pole double throw, off with switch actuator in center position.

H. Locking Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed three position switch actuator and momentary contacts; switches keyed alike; single pole double throw, off with switch actuator in center position.

2.4 WALL DIMMERS

A. Manufacturers:
1. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
2. Lutron Electronics Company, Inc; Maestro Series: www.lutron.com/#sle.
3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.

C. Control: Decorator rocker control type with preset slide adjustment.

D. Power Rating, Unless Otherwise Indicated or Required to Control the Load Indicated on the Drawings:

E. Provide locator light, illuminated with load off.

F. Provide accessory wall switches to match dimmer appearance when installed adjacent to each other.

2.5 FAN SPEED CONTROLLERS

A. Manufacturers:
1. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
2. Lutron Electronics Company, Inc; Maestro Series: www.lutron.com/#sle.
3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: 120 V AC, solid-state, full-range variable speed, slide control type with separate on/off switch, with integral radio frequency interference filtering, fan noise elimination circuitry, power failure preset memory, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1917.
1. Current Rating: 5 A unless otherwise indicated or required to control the load indicated on the drawings.

2.6 RECEPTACLES

A. Manufacturers:
1. Hubbell Incorporated: www.hubbell.com/#sle.
2. Hubbell Incorporated: www.hubbell-wiring.com.
3. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
4. Lutron Electronics Company, Inc; Designer Style: www.lutron.com/#sle.
5. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
6. Substitutions: See Section 016000 - Product Requirements.
7. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.

B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
2. NEMA configurations specified are according to NEMA WD 6.

C. Convenience Receptacles:
1. Standard Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
2. Automatically Controlled Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R; controlled receptacle marking on device face per NFPA 70; single or duplex as indicated on the drawings.
3. Isolated Ground Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, with ground contacts isolated from mounting strap; isolated ground triangle mark on device face; single or duplex as indicated on the drawings.
4. Weather Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
5. Tamper Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
6. Tamper Resistant and Weather Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

D. GFCI Receptacles:
1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.

a. Provide test and reset buttons of same color as device.

2. Standard GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations.
4. Tamper Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.
5. Tamper Resistant and Weather Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations.

E. USB Charging Devices:
1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.
a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.
b. Charging Capacity - Four-Port Devices: 4.2 A, minimum.
2. USB Charging/Tamper Resistant Receptacle Combination Devices: Two-port (Type A) USB charging device and receptacle, commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.
3. USB Charging Noncombination Devices: Four-port (Type A); rectangular decorator style.

F. Surge Protection Receptacles:
1. Surge Protection Receptacles - General Requirements: Listed and labeled as complying with UL 1449, Type 2 or 3.
a. Energy Dissipation: Not less than 240 J per mode.
b. Protected Modes: L-N, L-G, N-G.
c. UL 1449 Voltage Protection Rating (VPR): Not more than 700 V for L-N, L-G modes and 1200 V for N-G mode.
d. Diagnostics:
1) Visual Notification: Provide indicator light to report functional status of surge protection.

2. Standard Surge Protection Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
3. Isolated Ground Surge Protection Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, with ground contacts isolated from mounting strap.

G. Locking Receptacles: Industrial specification grade, configuration as indicated on the drawings.
1. Standard Locking Convenience Receptacles: Single, 20A, 125V, NEMA L5-20R.

H. Clock Hanger Receptacles: Single, 15A, 125V, NEMA 5-15R.

2.7 WALL PLATES

A. Manufacturers:
   1. Hubbell Incorporated: www.hubbell-wiring.com/#sle.
   2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
   3. Lutron Electronics Company, Inc: www.lutron.com/#sle.
   4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
   5. Substitutions: See Section 016000 - Product Requirements.
   6. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.

B. Wall Plates: Comply with UL 514D.
   1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
   2. Size: Standard.
   3. Screws: Metal with slotted heads finished to match wall plate finish.
   4. Provide screwless wallplates with concealed mounting hardware where indicated.

C. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.

D. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

E. Brass Wall Plates: Brushed satin finish, factory-coated to inhibit oxidation.

F. Aluminum Wall Plates: Smooth satin finish, clear anodized, factory-coated to inhibit oxidation.

G. Chrome Wall Plates: Smooth finish, chrome plated steel.

H. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.

I. Premarked Wall Plates: Factory labeled as indicated; hot stamped for nylon wall plates and engraved for metal wall plates.

J. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.

K. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

2.8 FLOOR BOX SERVICE FITTINGS

A. Manufacturers:
   1. Hubbell Incorporated: www.hubbell.com/#sle.
   2. Thomas & Betts Corporation: www.tnb.com/#sle.

3. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: Service fittings compatible with floor boxes provided under Section 260533.16 with components, adapters, and trims required for complete installation.

C. Above-Floor Service Fittings:
1. Single Service Pedestal Convenience Receptacles:
   a. Configuration: One standard convenience duplex receptacle.
2. Single Service Pedestal Communications Outlets:
   a. Configuration: One 1 inch bushed opening.
   b. Voice and Data Jacks: As specified in Section 271000.
3. Single Service Pedestal Furniture Feed:
   a. Configuration: One 3/4 inch knockout.
4. Dual Service Pedestal Combination Outlets:
   a. Configuration:
      1) Power: One standard convenience duplex receptacle.
      2) Communications: One 1 inch bushed opening.
      3) Voice and Data Jacks: As specified in Section 271000.
   b. Provide barrier to separate line and low voltage compartments.

D. Flush Floor Service Fittings:
1. Single Service Flush Convenience Receptacles:
   a. Cover: Rectangular.
   b. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
2. Single Service Flush Communications Outlets:
   a. Cover: Rectangular.
   b. Configuration: As specified on technology drawings.
   c. Voice and Data Jacks: As specified in Section 271000.
3. Single Service Flush Furniture Feed:
   a. Cover: Rectangular.
   b. Configuration: One 2-1/8 inch by 3/4 inch combination threaded opening(s).
4. Dual Service Flush Combination Outlets:
   a. Cover: Rectangular.
   b. Configuration:
      1) Power: One standard convenience duplex receptacle(s) with duplex flap opening(s).
      2) Communications: As specified on technology drawings.
      3) Voice and Data Jacks: As specified in Section 271000.
5. Dual Service Flush Furniture Feed:
   a. Cover: Rectangular.

b. Configuration:
1) Power: One 2-1/8 inch by 3/4 inch combination threaded opening(s).

2) Communications: One 2-1/8 inch by 1 inch combination threaded opening(s).

6. Accessories:
a. Tile Rings: Finish to match covers; configuration as required to accommodate specified covers.
b. Carpet Flanges: Finish to match covers; configuration as required to accommodate specified covers.

2.9 POKE-THROUGH ASSEMBLIES

A. Manufacturers:
1. Hubbell Incorporated: www.hubbell.com/#sle.
2. Thomas & Betts Corporation: www.tnb.com/#sle.
3. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.

C. Above-Floor Service Fittings:
1. Single Service Pedestal Convenience Receptacles:
a. Configuration: One standard convenience duplex receptacle.
2. Single Service Pedestal Communications Outlets:
a. Configuration: One 1 inch bushed opening.
b. Voice and Data Jacks: As specified in Section 271000.
3. Single Service Pedestal Furniture Feed:
a. Configuration: One 3/4 inch knockout.
4. Dual Service Pedestal Combination Outlets:
a. Configuration:
1) Power: One standard convenience duplex receptacle.

2) Communications: One 1 inch bushed opening.

3) Voice and Data Jacks: As specified in Section 271000.

b. Provide barrier to separate line and low voltage compartments.

D. Flush Floor Service Fittings:
1. Single Service Flush Convenience Receptacles:
a. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
2. Single Service Flush Furniture Feed:
a. Configuration: One 2 inch by 1-1/4 inch combination threaded opening(s).
3. Dual Service Flush Combination Outlets:

a. Cover: Hinged door(s).
b. Configuration:
1) Power: One standard convenience duplex receptacle(s).

2) Communications: As specified on technology drawings.

3) Voice and Data Jacks: As specified in Section 271000.

4. Dual Service Flush Furniture Feed:
a. Configuration:
1) Power: One 3/4 inch threaded opening(s).

2) Communications: Two 1/2 inch threaded opening(s).

5. Accessories:
a. Closure Plugs: Size and fire rating as required to seal unused core hole and maintain fire rating of floor.

2.10 ACCESS FLOOR BOXES

A. Manufacturers - Access Floor Boxes:
1. Hubbell Incorporated: www.hubbell-wiring.com/#sle.
2. Thomas & Betts Corporation: www.tnb.com/#sle.
3. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: Metallic multi-service box suitable for mounting in access floor system specified in Section 096900.

C. Configuration:
1. Power: Two standard convenience duplex receptacle(s).
2. Communications: As specified on technology drawings.
3. Voice and Data Jacks: Provided by others.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that floor boxes are adjusted properly.

F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

G. Verify that core drilled holes for poke-through assemblies are in proper locations.

H. Verify that openings in access floor are in proper locations.

I. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 260533.16 as required for installation of wiring devices provided under this section.
   1. Mounting Heights: Unless otherwise indicated, as follows:
      a. Wall Switches: 48 inches above finished floor.
      b. Wall Dimmers: 48 inches above finished floor.
      c. Fan Speed Controllers: 48 inches above finished floor.
      d. Receptacles: 18 inches above finished floor or 6 inches above counter.
   2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
   3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
   4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Engineer to obtain direction prior to proceeding with work.
   5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.

C. Install wiring devices in accordance with manufacturer's instructions.

D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

H. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.

I. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.

J. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.

K. Install wiring devices plumb and level with mounting yoke held rigidly in place.

L. Install wall switches with OFF position down.

M. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

N. Do not share neutral conductor on branch circuits utilizing wall dimmers.

O. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

P. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

Q. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

R. Identify wiring devices in accordance with Section 260553.

S. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.

3.4 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect each wiring device for damage and defects.

C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.

D. Test each receptacle to verify operation and proper polarity.

E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.

F. Inspect each surge protection receptacle to verify surge protection is active.

G. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

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

B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Engineer.

3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 262726

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SECTION 263100 - PHOTOVOLTAIC COLLECTORS

PART 2 PRODUCTS

1.1 PHOTOVOLTAIC SYSTEM REQUIREMENTS

A. Provide complete photovoltaic system consisting of photovoltaic modules and associated balance of system components necessary for connection to facility electrical system.

B. System Description:
1. Photovoltaic array is roof-mounted in appropriate locations determined by system provider .
2. Orientation of array is by solar system provider to maximize the power output.
3. System does not include interconnection with utility grid (off-grid system).
a. Utility metering configuration: Net metering.
4. System does not include battery storage system.
5. System does not include engine generator.
6. System includes DC system surge protection.
7. System includes monitoring system.
8. Owner intends to secure funds from available federal, state, and utility company rebate and incentive programs.

C. Capacity:
1. Minimum Expected Annual Energy Production: 10 percent of facility expected annual energy requirements, as calculated by National Renewable Energy Laboratory's PVWatts calculator or approved equivalent.
2. Total Nominal Rated Power Output of Array: Equal to or greater than the rated output of the basis of design array.
3. Nominal Rated Power Output of Individual Modules: Equal to or greater than the rated output of the basis of design module.

D. Size:
1. Array: Designed to fit within the area designated on the drawings.
2. Individual Modules: Size is not critical.

E. Appearance:
1. Arrange array such that modules are aligned with uniform spacing.
2. Make no alterations affecting appearance of building exterior or interior without approval of Architect.
3. Final determination of acceptable appearance is by Architect.

F. Fire Resistance Rating: Provide photovoltaic module and mounting system combination that together with the roof covering form a system listed in accordance with UL 1703 to provide a fire rating equal to or better than the required fire rating of the roof.

G. Provide photovoltaic system and associated components suitable for wind loads, snow loads, seismic loads, and other structural design considerations of the installed location.
   1. Comply with ASCE 7.
   2. Include structural calculations demonstrating compliance with submittals.

H. Provide photovoltaic system and associated components suitable for continuous operation under the service conditions at the installed location.

I. Provide products listed, classified, and labeled as suitable for the purpose intended.

J. Provide photovoltaic system and associated components that qualify for available federal, state, and utility company rebate and incentive programs.

K. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system.

L. DC Arc Fault Circuit Protection: Provide DC photovoltaic arc-fault protection devices listed as complying with UL 1699B as required for compliance with NFPA 70.

M. Rapid Shutdown of Photovoltaic Systems on Buildings: Provide listed equipment arranged to provide rapid shutdown in accordance with NFPA 70.

N. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

O. Arrange array to provide adequate access to rear of string(s) for maintenance.

P. Arrange array to minimize shading during peak production periods.

Q. Roof-Mounted Arrays:
   1. Arrange array such that normal roof drainage is not affected.
   2. Arrange array to maintain required safety clearances from edges of roof as required by authority having jurisdiction.
   3. Arrange array to maintain access and clearance requirements for other roof-mounted equipment.
   4. Arrange array to avoid spanning of expansion joints.

1.2 PHOTOVOLTAIC MODULES

A. Acceptable Module Types: Either crystalline silicon or thin film modules complying with specified requirements will be considered for this project.

B. General Requirements:

1. Photovoltaic Modules: Factory assembled; consisting of photovoltaic cells, frame, junction box, cables for series connection, and bypass diodes for shade tolerance; rated for 600 V DC; complying with IEC 61215-1 and IEC 61215-2 and listed as complying with UL 1703.
2. Crystalline Silicon Photovoltaic Modules: Comply with IEC 61215-1-1.
3. Thin Film Photovoltaic Modules: Comply with IEC 61215-1-2, IEC 61215-1-3, or IEC 61215-1-4 as applicable.
4. Frame: Anodized aluminum.
5. Factory-Installed Junction Box: Weatherproof, with factory-installed terminals and bypass diodes.
6. Factory-Installed Cables: Type USE-2 or listed photovoltaic (PV) wire with polarized locking connectors.
7. Unless otherwise indicated, specified module performance characteristics are rated under Standard Test Conditions (STC).
8. Power Rating Tolerance: Plus 10 or minus 5 percent.
    a. Include flash test data for each module with source quality control reports to demonstrate compliance.

1.3 BALANCE OF SYSTEM COMPONENTS

A. Photovoltaic Module Mounting System:
1. Provide complete mounting system compatible with modules to be installed and suitable to properly install them in the location indicated, including all necessary hardware and accessories.
2. Support Structure and Associated Hardware Materials: Use aluminum, galvanized steel, or stainless steel.
3. Roof-Mounted Arrays:
    a. Acceptable System Types: Either non-penetrating or penetrating systems complying with specified requirements will be considered for this project.
    b. Provide system compatible with the roof at the installed location.
    c. Module Tilt Angle: As required to provide maximum energy production for installed location.
    d. Provide minimum clearance of 3 inches between roof and module for air circulation and drainage.

B. Photovoltaic Combiner Boxes:
1. Provide combiner box(es) for termination of strings as indicated or as required for the array configuration installed.
2. Combiner Boxes: Rated for 600 V DC; current ratings suitable for connected strings; equipped with fuseholders; listed as complying with UL 1741.
3. Fuseholders: Touch-safe; suitable to accept fuses indicated.
4. Number of Input Circuits: As indicated or as required for termination of strings, with minimum of 25 percent spare capacity for future expansion.
5. Enclosure: NEMA 250, Type 3R, unless otherwise indicated.
6. Provide integral load-break rated disconnect.
7. Provide with capability of current monitoring for individual strings.

C. Photovoltaic Inverters:
   1. Provide inverter(s) as indicated or as required for connection of the photovoltaic array DC system to the AC system indicated.
   2. Inverters: Suitable for the requirements of the connected array; output configuration compatible with connected system; listed as complying with UL 1741; furnished with the following features:
      a. Maximum power point tracking (MPPT).
      b. LCD display.
      c. Integral AC disconnect.
      d. Integral DC disconnect.
      e. Integral DC ground fault detection and interruption (GFDI).
      f. Communications Interface: As required for connection to system indicated.
   3. Grid-Tied Inverters: Comply with IEEE 1547, including over/under grid voltage and frequency protection, and anti-islanding protection to automatically disconnect upon loss of utility power and to remain disconnected until utility power restoration has been maintained for five minutes.
   4. Grounded Photovoltaic DC Systems: Furnish with integral isolation transformer. Transformerless inverters may be used if a separate isolation transformer is provided.
   5. Total Harmonic Distortion: Less than five percent.
   6. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.

D. Isolation Transformers: Comply with Section 262200 .

E. Enclosed Switches, in Addition to Requirements of Section 262816.16:
   1. Switches for DC System: Rated for 600 V DC.
   2. Switches Connected to Supply Side of Service Disconnecting Means: Listed and labeled as suitable for use as service equipment according to UL 869A.

F. Surge Protective Devices, in Addition to Requirements of Section 264300:
   1. Surge Protective Devices for DC System:
      a. Rated for 600 V DC.
      b. Listed and labeled as complying with UL 1449, Type 1.
      c. Surge Current Rating: Not less than 50 kA per mode.
      d. UL 1449 Nominal Discharge Current (I-n): 20 kA.

G. Molded-Case Circuit Breakers and Switches for DC System: Rated for 600 V DC; listed as complying with UL 489B.

H. Fuses, in Addition to Requirements of Section 262813:
   1. Fuses for DC System: Rated for 600 V DC.
   2. Fuses for Protection of Photovoltaic Strings and Arrays: Photovoltaic fuses listed as complying with UL 2579.

I. Monitoring System:
   1. Provide a system to monitor photovoltaic system performance including all sensors, dataloggers, connections, software, equipment and accessories necessary for a complete operating system.
   2. System communications interfaces to be wired or wireless, with compatible interconnected components.
      a. Provide suitable raceway, minimum 3/4 inch trade size, for all required wired connections.
   3. System to monitor and record, in 15 minute intervals:
      a. Inverter status.
      b. Instantaneous power (kW).
      c. Cumulative energy production (kWh).
   4. Energy Production Meter: Revenue grade, with accuracy of plus or minus two percent.
   5. System real-time and historical data to be accessible from the following locations:
      a. Personal computer(s), via internet connection.
      b. Remote personal display(s), quantity and location as indicated on the drawings.
      c. Remote public display(s), quantity and location as indicated on the drawings.
   6. System to provide alarm notification via e-mail or instant message.
   7. System to be compatible with third party monitoring service to be selected by Owner.

1.4 SOURCE QUALITY CONTROL

A. Factory test the following products to verify operation and performance characteristics. Include test reports with submittals.
   1. Photovoltaic modules.
   2. Photovoltaic inverters.

PART 3 EXECUTION

2.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings and configurations of system components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive system components.

D. Verify that conditions are satisfactory for installation prior to starting work.

2.2 PREPARATION

A. Use open circuiting, short circuiting, or opaque covering to disable modules, array or portions of array prior to installation and service.

B. Roof-Mounted Arrays: Protect roof and adjacent roof-mounted items from damage.

2.3 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

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

C. Provide required support and attachment in accordance with Section 260529.

D. Provide required seismic controls in accordance with Section 260548.

E. Mount equipment such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor, ground, or working platform.

F. Circuiting Requirements. in Addition to Requirements of Section 260519:
1. Photovoltaic DC System Conductor Color Code:
a. Negative Grounded System:
1) Positive: Red.
2) Negative/Grounded: White.
b. Positive Grounded System:
1) Positive/Grounded: White.
2) Negative: Black.
c. Ungrounded System:
1) Positive: Red.
2) Negative: Black.
2. Maintain separation of photovoltaic and non-photovoltaic circuits in accordance with NFPA 70.

G. Grounding and Bonding Requirements, in Addition to Requirements of Section 260526:
1. Ensure that there is only one AC System bonding connection between grounding system and grounded/neutral conductor, including external connections and connections internal to equipment.
2. Provide auxiliary electrodes for photovoltaic array grounding in accordance with NFPA 70.

H. Identification Requirements, in Addition to Those Specified in Section 260553:
1. Use identification nameplate or means of identification acceptable to authority having jurisdiction to identify the presence of multiple power sources and the location of main service disconnecting means and each photovoltaic system disconnecting means. Locate at main service disconnecting means and at each photovoltaic system disconnecting means. Verify format and descriptions with authorities having jurisdiction.

2. Use identification nameplate to identify each photovoltaic system disconnecting means with text "PV SYSTEM DISCONNECT".
3. Use identification nameplate or identification label to identify systems equipped with rapid shutdown and associated rapid shutdown switch(es). Format, descriptions, and locations to comply with NFPA 70 and requirements of authorities having jurisdiction.
4. Use identification nameplate or identification label to identify the information required by NFPA 70 for marking of direct-current photovoltaic power sources. Locate at each DC disconnect means requiring marking.
5. Use identification nameplate or identification label to identify the interactive system point of interconnection at the disconnecting means as a power source and with the rated AC output current and the nominal operating AC voltage.
6. Where the inverter output connection is located in a panelboard on the opposite (load) end from the input feeder location or main circuit location in order to meet requirements of NFPA 70, use identification nameplate or identification label to identify the overcurrent device with the word message "Warning; Inverter output connection; Do not relocate this overcurrent device".
7. Use warning labels to identify electrical hazards for photovoltaic system disconnecting means. Include the word message "Warning - Electric Shock Hazard; Terminals on the line and load sides may be energized in the open position" or approved equivalent.
8. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for photovoltaic systems equipped with DC ground-fault protection in accordance with NFPA 70. Include the word message "Warning - Electric Shock Hazard; If a ground fault is indicated, normally grounded conductors may be ungrounded and energized".
9. Use wire and cable markers to identify photovoltaic system source, output, and inverter circuit conductors at all points of termination, connection, and splices.
10. Use voltage markers, identification labels, stenciled text, or suitable permanent marking approved by authority having jurisdiction to identify exposed raceways, cable trays, pull boxes, junction boxes, and conduit bodies with the text "Warning: Photovoltaic Power Source" at maximum intervals of 10 feet in accordance with NFPA 70.

2.4 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. See article "SYSTEM STARTUP" below for additional requirements related to testing and inspection.

C. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

D. Inspection and testing to include, at a minimum:
1. Inspect each system component for damage and defects.
2. Verify that equipment enclosures, boxes, and associated connections installed outdoors are weatherproof.

3. Verify proper wiring connections have been made and check for conductor continuity. Verify proper polarity.
4. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
5. Perform insulation resistance tests.
    a. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
6. Measure and record open circuit voltage of each string.
7. Measure and record voltages at the inverter AC and DC inputs.
8. Measure and record operating current for each string, sub-array, and array.
9. Measure and record AC output power.
10. Perform inverter functional test.
    a. Grid-Tied Inverters: Include simulation of loss of utility power and subsequent power restoration.
11. Verify proper operation of monitoring system.

E. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

F. Diagnostic Period: After successful completion of inspections and tests, operate system in normal mode for at least 14 days without any system or equipment malfunctions.
1. Record all system operations and malfunctions.
2. If a malfunction occurs, start diagnostic period over after correction of malfunction.

G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

H. Repair roof or adjacent roof-mounted items damaged as a result of work of this section.

2.5 SYSTEM STARTUP

A. Provide services of a manufacturer's authorized representative to assist in performing system startup. Include manufacturer's detailed startup procedures with submittals.

B. Obtain Owner's approval prior to performing system startup.

C. Grid-Tied Systems: Obtain Utility Company's approval prior to performing system startup.

D. Prepare and start system in accordance with manufacturer's instructions.

2.6 CLEANING

A. Clean modules using only methods recommended by manufacturer to avoid scratches and other damage. Clean exposed surfaces on other components to remove dirt, paint, or other foreign material and restore to match original factory finish.

2.7 COMMISSIONING

A. See Section 019113 - General Commissioning Requirements for commissioning requirements.

2.8 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. See Section 017900 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

D. Training: Train Owner's personnel on operation, adjustment, and maintenance of photovoltaic system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of four hours of training.
   3. Instructor: Manufacturer's authorized representative.
   4. Location: At project site.

2.9 PROTECTION

A. Protect installed products from subsequent construction operations.

2.10 MAINTENANCE

A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner, a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of photovoltaic system for two years from date of Substantial Completion, to include the work described below; Include a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

C. Conduct site visit at least once every six months to perform inspection, testing, and preventive maintenance. Conduct tests similar to those made during original field quality control testing. Submit report to Owner comparing test results with those of original tests along with evaluations and recommendations.

D. Provide trouble call-back service upon notification by Owner:
   1. Include allowance for call-back service during normal working hours at no extra cost to Owner.

2. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION 263100

SECTION 264300 - SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surge protective devices for service entrance locations.

B. Surge protective devices for distribution locations.

C. Surge protective devices for branch panelboard locations.

1.2 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 262300 - Low-Voltage Switchgear.

C. Section 262413 - Switchboards.

D. Section 262416 - Panelboards.

1.3 REFERENCE STANDARDS

A. MIL-STD-220 - Method of Insertion Loss Measurement 2009c (Validated 2019).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

D. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.

E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 1283 - Standard for Electromagnetic Interference Filters Current Edition, Including All Revisions.

G. UL 1449 - Standard for Surge Protective Devices Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to ordering equipment.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
   1. SPDs with EMI/RFI filter: Include noise attenuation performance.

C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.

D. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
   1. UL 1449.
   2. UL 1283 (for Type 2 SPDs).

E. Field Quality Control Test Reports.

F. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.

H. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

I. Project Record Documents: Record actual connections and locations of surge protective devices.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

C. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Field-installed, Externally Mounted Surge Protective Devices:

B. Factory-installed, Internally Mounted Surge Protective Devices:
1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.

C. Substitutions: See Section 016000 - Product Requirements.

D. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

E. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.

2.2 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. Unless otherwise indicated, provide field-installed, externally-mounted or factory-installed, internally-mouonted SPDs.

C. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.

D. Protected Modes:
1. Wye Systems: L-N, L-G, N-G, L-L.
2. Delta Systems: L-G, L-L.

E. UL 1449 Voltage Protection Ratings (VPRs):
1. Equivalent to basis of design.

F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

G. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
1. Indoor clean, dry locations: Type 1.
2. Outdoor locations: Type 3R.

H. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.
2. Provide flush-mounted SPD where mounted in public areas or adjacent to flush-mounted equipment.

I. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.
1. Switchgear: See Section 262300.
2. Switchboards: See Section 262413.
3. Panelboards: See Section 262416.

2.3 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

A. Surge Protective Device:
1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.

3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
    a. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.
6. Diagnostics:
    a. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.
    b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
    c. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
    d. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.
7. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.4 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

A. Distribution locations include SPDs connected to distribution panelboards, motor control centers, and busway.

B. Surge Protective Device:
1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 80 kA per mode/160 kA per phase.
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
    a. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.
6. Diagnostics:
    a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
    b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
    c. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.

d. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.

7. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.5 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

A. Surge Protective Device:
1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 60 kA per mode/120 kA per phase.
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
   a. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.
6. Diagnostics:
   a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
   b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
   c. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
   d. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.
7. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.

C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of drawings and manufacturer's instructions.

D. Verify system grounding and bonding is in accordance with Section 260526, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

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

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Unless indicated otherwise, connect service entrance surge protective device on load side of service disconnect main overcurrent device.

E. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.

F. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.

G. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 260526 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

H. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS Section 7.19.1.

D. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

3.4 CLEANING

A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 264300

SECTION 265100 - INTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Interior luminaires.

B. Emergency lighting units.

C. Exit signs.

D. Ballasts and drivers.

E. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 260529 - Hangers and Supports for Electrical Systems.

B. Section 260533.16 - Boxes for Electrical Systems.

C. Section 260548 - Vibration and Seismic Controls for Electrical Systems.

D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 260923 - Lighting Control Devices.

F. Section 262726 - Wiring Devices: Manual wall switches and wall dimmers.

1.3 REFERENCE STANDARDS

A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code) 2013 (Corrigendum 2019).

B. IES LM-63 - Approved Method: IES Standard File Format for the Electronic Transfer of Photometric Data and Related Information 2019.

C. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products 2019.

D. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources 2021.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

F. NECA/IESNA 500 - Standard for Installing Indoor Lighting Systems 2006.

G. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems 1999 (Reaffirmed 2006).

H. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Disharge Ballasts 2020.

I. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility 2012 (Reaffirmed 2018).

J. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. UL 924 - Emergency Lighting and Power Equipment Current Edition, Including All Revisions.

M. UL 1598 - Luminaires Current Edition, Including All Revisions.

N. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
4. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings:
1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
2. Provide photometric calculations where luminaires are proposed for substitution upon request.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
   1. LED Luminaires:
      a. Include estimated useful life, calculated based on IES LM-80 test data.
      b. Include IES LM-79 test report upon request.
   2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IES LM-63 standard format upon request.
   3. Ballasts: Include wiring diagrams and list of compatible lamp configurations.
   4. Lamps: Include rated life, color temperature, color rendering index (CRI), and initial and mean lumen output.

D. Sustainable Design Documentation: Submit manufacturer's product data on lamp mercury content and rated lamp life, showing compliance with specified requirements.

E. Samples:
   1. Provide one sample(s) of each specified luminaire upon request.
   2. Provide one sample(s) of each custom luminaire upon request.
   3. Provide one sample(s) of each luminaire proposed for substitution upon request.
   4. Provide one sample(s) of each product finish illustrating color and texture upon request.

F. Certificates for Dimming Ballasts: Manufacturer's documentation of compatibility with dimming controls to be installed.

G. Field quality control reports.

H. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

I. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.
   2. Extra Lenses and Louvers: Two percent of total quantity installed for each type, but not less than one of each type.
   3. Extra Lamps: Ten percent of total quantity installed for each type, but not less than two of each type.
   4. Extra Ballasts: Two percent of total quantity installed for each type, but not less than one of each type.

K. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Provide 3-year manufacturer warranty for LED luminaires, including drivers.

C. Provide 5-year pro-rata warranty for batteries for emergency lighting units.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

2.2 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Recessed Luminaires:
1. Ceiling Compatibility: Comply with NEMA LE 4.
2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.
4. Air-Handling Recessed Fluorescent Luminaires: Suitable for air supply/return, heat removal, or combination as indicated.

H. HID Luminaires:
1. HID High Bay Luminaires: Provide safety chain or power hook unless otherwise indicated.
2. HID Luminaires with Quartz Restrike Systems: Factory-installed supplementary quartz lamp automatically switches on when power interruption causes primary HID lamp to drop out or during cold startup.

I. LED Luminaires:
1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

J. LED Tape Lighting Systems: Provide all power supplies, drivers, cables, connectors, channels, covers, mounting accessories, and interfaces as necessary to complete installation.
1. LED Tape - General Requirements:
   a. Listed.
   b. Designed for field cutting in accordance with listing.
   c. Wet Location Applications: IEC 60529, IP 68 (waterproof) rated.
2. White LED Tape:
   a. Correlated Color Temperature (CCT): 4000 K unless otherwise indicated.
   b. Color Rendering Index (CRI): Not less than 90.

K. Track Lighting Systems: Provide track compatible with specified track heads, with all connectors, power feed fittings, dead ends, hangers and canopies as necessary to complete installation.

L. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.3 EMERGENCY LIGHTING UNITS

A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

C. Battery:
1. Size battery to supply all connected lamps, including emergency remote heads where indicated.

D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

E. Provide low-voltage disconnect to prevent battery damage from deep discharge.

F. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

G. Where indicated, provide units with integral time delay to maintain emergency illumination for 90 minutes after restoration of normal power source.

H. Accessories:
1. Provide compatible accessory mounting brackets where indicated or required to complete installation.
2. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
3. Provide compatible accessory wire guards where indicated.
4. Where indicated, provide emergency remote heads that are compatible with the emergency lighting unit they are connected to and suitable for the installed location.

2.4 EXIT SIGNS

A. Description: Exit signs complying with NFPA 101 and applicable state and local codes, and listed and labeled as complying with UL 924.
1. Number of Faces: Single- or double-face as indicated or as required for installed location.
2. Directional Arrows: As indicated or as required for installed location.

B. Powered Exit Signs: Internally illuminated with LEDs unless otherwise indicated.
   1. Self-Powered Exit Signs:
      a. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
      b. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
      c. Provide low-voltage disconnect to prevent battery damage from deep discharge.
      d. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

C. Accessories:
   1. Provide compatible accessory high-impact polycarbonate vandal shields where indicated.
   2. Provide compatible accessory wire guards where indicated.

2.5 BALLASTS AND DRIVERS

A. Ballasts/Drivers - General Requirements:
   1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
   2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
   3. Electronic Ballasts/Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.

B. Dimmable LED Drivers:
   1. Dimming Range: Continuous dimming from 100 percent to one percent relative light output unless dimming capability to lower level is indicated, without flicker.
   2. Control Compatibility: Fully compatible with the dimming controls to be installed.
      a. Wall Dimmers: See Section 262726.
      b. Daylighting Controls: See Section 260923.
      c. Network Lighting Controls: As indicated on drawings.

2.6 ACCESSORIES

A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.

B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.

C. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

D. Fire-Rated Luminaire Enclosures:

1. Provide as required to preserve fire resistance rating of building elements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 260533.16 as required for installation of luminaires provided under this section.

B. Perform work in accordance with NECA 1 (general workmanship).

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

D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).

E. Provide required support and attachment in accordance with Section 260529.

F. Provide required seismic controls in accordance with Section 260548.

G. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

H. Suspended Ceiling Mounted Luminaires:
   1. Do not use ceiling tiles to bear weight of luminaires.
   2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.

3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
4. Secure pendant-mounted luminaires to building structure.
5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gauge, connected from opposing corners of each recessed luminaire to building structure.
7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.

I. Recessed Luminaires:
1. Install trims tight to mounting surface with no visible light leakage.
2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.

J. Suspended Luminaires:
1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet between supports.
4. Install canopies tight to mounting surface.
5. Unless otherwise indicated, support pendants from swivel hangers.

K. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

L. Install accessories furnished with each luminaire.

M. Bond products and metal accessories to branch circuit equipment grounding conductor.

N. Emergency Lighting Units:
1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

O. Exit Signs:
1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

P. Remote Ballasts: Install in accessible location as indicated or as required to complete installation, using conductors per manufacturer's recommendations not exceeding manufacturer's recommended maximum conductor length to luminaire.

Q. Identify luminaires connected to emergency power system in accordance with Section 260553.

R. Install lamps in each luminaire.

S. Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

3.4 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Test self-powered exit signs, emergency lighting units, and fluorescent emergency power supply units to verify proper operation upon loss of normal power supply.

E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Engineer.

3.5 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.

B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Engineer or authority having jurisdiction.

C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Engineer or authority having jurisdiction.

3.6 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. See Section 017900 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of luminaires to Engineer, and correct deficiencies or make adjustments as directed.

D. Just prior to Substantial Completion, replace all lamps that have failed.

3.8 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 265100

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SECTION 265600 - EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Exterior luminaires.

B. Ballasts.

C. Lamps.

D. Poles and accessories.

E. Luminaire accessories.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Materials and installation requirements for concrete bases for poles.

B. Section 260526 - Grounding and Bonding for Electrical Systems.

C. Section 260529 - Hangers and Supports for Electrical Systems.

D. Section 260533.16 - Boxes for Electrical Systems.

E. Section 260548 - Vibration and Seismic Controls for Electrical Systems.

F. Section 262726 - Wiring Devices: Receptacles for installation in poles.

G. Section 262813 - Fuses.

1.3 REFERENCE STANDARDS

A. AASHTO LTS - Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals 2013 (Revised 2019).

B. ANSI C82.4 - American National Standard for Lamp Ballasts - Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps 2017.

C. ANSI O5.1 - American National Standard for Wood Poles - Specifications and Dimensions 2017.

D. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code) 2013 (Corrigendum 2019).

E. IEEE C2 - National Electrical Safety Code(R) (NESC(R)) 2023.

F. IES LM-63 - Approved Method: IES Standard File Format for the Electronic Transfer of Photometric Data and Related Information 2019.

G. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products 2019.

H. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources 2021.

I. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

J. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems 2000 (Reaffirmed 2006).

K. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Disharge Ballasts 2020.

L. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility 2012 (Reaffirmed 2018).

M. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

N. UL 1029 - High-Intensity-Discharge Lamp Ballasts Current Edition, Including All Revisions.

O. UL 1598 - Luminaires Current Edition, Including All Revisions.

P. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
   2. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings:
   1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

2. Provide photometric calculations where luminaires are proposed for substitution upon request.
3. Provide structural calculations for each pole proposed for substitution.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
1. LED Luminaires:
   a. Include estimated useful life, calculated based on IES LM-80 test data.
   b. Include IES LM-79 test report upon request.
2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IES LM-63 standard format upon request.
3. Lamps: Include rated life and initial and mean lumen output.
4. LED Retrofit Luminaire Conversion Kits: Include list of compatible luminaires and/or criteria for compatibility.
5. Poles: Include information on maximum supported effective projected area (EPA) and weight for the design wind speed.

D. Sustainable Design Documentation: Submit manufacturer's product data on lamp mercury content and rated lamp life, showing compliance with specified requirements.

E. Samples:
1. Provide one sample(s) of each specified luminaire upon request.
2. Provide one sample(s) of each custom luminaire upon request.
3. Provide one sample(s) of each luminaire proposed for substitution upon request.
4. Provide one sample of each product finish illustrating color and texture upon request.

F. Certificates for Poles and Accessories: Manufacturer's documentation that products are suitable for the luminaires to be installed and comply with designated structural design criteria.

G. Field Quality Control Reports.
1. Include test report indicating measured illumination levels.

H. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

I. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 016000 - Product Requirements, for additional provisions.
2. Extra Lamps: Ten percent of total quantity installed for each type, but not less than two of each type.

3. Extra Ballasts: Two percent of total quantity installed for each type, but not less than one of each type.
4. Touch-Up Paint: 2 gallons, to match color of pole finish.

K. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

C. Receive, handle, and store wood poles in accordance with ANSI O5.1.

1.8 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Provide 2-year manufacturer warranty for all LED luminaires, including drivers.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

2.2 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.

H. Recessed Luminaires:
   1. Ceiling Compatibility: Comply with NEMA LE 4.
   2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
   3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

I. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

J. HID Luminaires:
   1. HID High Bay Luminaires: Provide safety chain or power hook unless otherwise indicated.
   2. HID Luminaires with Quartz Restrike Systems: Factory-installed supplementary quartz lamp automatically switches on when power interruption causes primary HID lamp to drop out or during cold startup.

K. LED Luminaires:
   1. Components: UL 8750 recognized or listed as applicable.
   2. Tested in accordance with IES LM-79 and IES LM-80.
   3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

L. LED Tape Lighting Systems: Provide all power supplies, drivers, cables, connectors, channels, covers, mounting accessories, and interfaces as necessary to complete installation.
   1. LED Tape - General Requirements:
      a. Listed.
      b. Designed for field cutting in accordance with listing.
      c. Wet Location Applications: IEC 60529, IP 68 (waterproof) rated.
   2. White LED Tape:

a. Correlated Color Temperature (CCT): 3000 K unless otherwise indicated.
b. Color Rendering Index (CRI): Not less than 90.

M. Exposed Hardware: Stainless steel.

2.3 BALLASTS AND DRIVERS

A. Ballasts/Drivers - General Requirements:
1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
3. Electronic Ballasts/Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.

B. Dimmable LED Drivers:
1. Dimming Range: Continuous dimming from 100 percent to one percent relative light output unless dimming capability to lower level is indicated, without flicker.
2. Control Compatibility: Fully compatible with the dimming controls to be installed.

C. High Intensity Discharge (HID) Ballasts: Unless otherwise indicated, provide electromagnetic ballasts complying with ANSI C82.4 and listed and labeled as complying with UL 1029.
1. Input Voltage: Suitable for operation at voltage of connected source, with variation tolerance of plus or minus 5 percent.
2. Power Factor: Not less than 0.90 unless otherwise indicated.
3. Lamp Starting Temperature: Capable of starting standard lamp(s) at a minimum of -22 degrees F.

2.4 LAMPS

A. Lamps - General Requirements:
1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Engineer to be inconsistent in perceived color temperature.

2.5 POLES

A. All Poles:
1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.
2. Structural Design Criteria:
a. Comply with AASHTO LTS.

b. Wind Load: Include effective projected area (EPA) of luminaire(s) and associated supports and accessories to be installed.
c. Dead Load: Include weight of proposed luminaire(s) and associated supports and accessories.
d. Include structural calculations demonstrating compliance with submittals.

3. Material: Steel, unless otherwise indicated.
4. Shape: Square straight, unless otherwise indicated.
5. Finish: Match luminaire finish, unless otherwise indicated.
6. Mounting Height: 14 feet, unless otherwise indicated.
7. Mounting: Install on concrete foundation, height as indicated on the drawings, unless otherwise indicated.
8. Unless otherwise indicated, provide with the following features/accessories:
   a. Top cap.
   b. Handhole.
   c. Anchor bolts with leveling nuts or leveling shims.
   d. Anchor base cover.
   e. Provision for pole-mounted weatherproof GFI receptacle where indicated.
   f. Brackets.
   g. Hinged base.
   h. Pole-top tenon, size as required for installed luminaire or bracket.

B. Metal Poles: Provide ground lug, accessible from handhole or transformer base.

2.6 ACCESSORIES

A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.

B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.

C. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 260533.16 as required for installation of luminaires provided under this section.

B. Perform work in accordance with NECA 1 (general workmanship).

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

D. Install luminaires in accordance with NECA/IESNA 501.

E. Provide required support and attachment in accordance with Section 260529.

F. Provide required seismic controls in accordance with Section 260548.

G. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

H. Recessed Luminaires:
1. Install trims tight to mounting surface with no visible light leakage.
2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.

I. Suspended Luminaires:
1. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
2. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet in length, with no more than 4 feet between supports.
3. Install canopies tight to mounting surface.
4. Unless otherwise indicated, support pendants from swivel hangers.

J. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

K. Pole-Mounted Luminaires:
1. Maintain the following minimum clearances:
   a. Comply with IEEE C2.

b. Comply with utility company requirements.

2. Foundation-Mounted Poles:
   a. Provide cast-in-place concrete foundations for poles as indicated, in accordance with Section 033000.
      1) Install anchor bolts plumb per template furnished by pole manufacturer.
      2) Position conduits to enter pole shaft.
   b. Install foundations plumb.
   c. Install poles plumb, using leveling nuts or shims as required to adjust to plumb.
   d. Tighten anchor bolt nuts to manufacturer's recommended torque.
   e. Install non-shrink grout between pole anchor base and concrete foundation, leaving small channel for condensation drainage.
   f. Install anchor base covers or anchor bolt covers as indicated.
3. Embedded Poles: Install poles plumb as indicated.
4. Grounding:
   a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.
   b. Provide supplementary ground rod electrode as specified in Section 260526 at each pole bonded to grounding system as indicated.
5. Install separate service conductors, 12 AWG copper, from each luminaire down to handhole for connection to branch circuit conductors.
6. Install non-breakaway in-line fuse holders and fuses complying with Section 262813 in pole handhole or transformer base for each ungrounded conductor.
7. Install weather resistant GFI duplex receptacle with weatherproof cover as specified in Section 262726 in designated poles.

L. Install accessories furnished with each luminaire.

M. Bond products and metal accessories to branch circuit equipment grounding conductor.

N. Install lamps in each luminaire.

3.4 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Engineer.

E. Measure illumination levels at night with calibrated meters to verify compliance with performance requirements. Record test results in written report to be included with submittals.

3.5 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.

B. Luminaires with Field-Rotatable Optics: Position optics according to manufacturer's instructions to achieve lighting distribution as indicated or as directed by Engineer.

3.6 CLEANING

A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. See Section 017900 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of luminaires to Engineer, and correct deficiencies or make adjustments as directed.

D. Just prior to Substantial Completion, replace all lamps that have failed.

3.8 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 265600

SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other communications work.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete.

B. Section 055000 - Metal Fabrications: Materials and requirements for fabricated metal supports.

1.3 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2019.

D. BICSI ITSIMM - Information Technology Systems Installation Methods Manual (ITSIMM), 8th Edition 2022.

E. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition 2019.

F. MFMA-4 - Metal Framing Standards Publication 2004.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

H. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. TIA-569 - Telecommunications Pathways and Spaces 2019e.

J. UL 5B - Strut-Type Channel Raceways and Fittings Current Edition, Including All Revisions.

K. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
   2. Coordinate work to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
   4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
   5. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 033000.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cable supports, channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.

C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

D. Evaluation Reports: For products specified as requiring evaluation and recognition by ICC Evaluation Service, LLC (ICC-ES), provide current ICC-ES evaluation reports upon request.

1.6 QUALITY ASSURANCE

A. Maintain at project site one copy of each referenced document that prescribes execution requirements.

B. Installer Qualifications for Powder-Actuated Fasteners: Certified by fastener system manufacturer with current operator's license.

C. Installer Qualifications for Field Welding: See Section 055000.

D. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
1. Comply with the following. Where requirements differ, comply with most stringent.
   a. TIA-569.
   b. NFPA 70.
   c. Applicable building code.
   d. Requirements of authorities having jurisdiction.
2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of communications work.
3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
6. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
7. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
   a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
   b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
   c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
   d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Materials for Metal Fabricated Supports: See Section 055000.

C. Conduit Supports: Straps and clamps suitable for conduit to be supported.
1. Manufacturers:
   a. ABB: www.electrification.us.abb.com/#sle.
   b. Eaton Corporation: www.eaton.com/#sle.
   c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
   d. nVent; Caddy: www.nvent.com/#sle.
   e. Substitutions: See Section 016000 - Product Requirements.
2. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
3. Conduit Clamps: Bolted type unless otherwise indicated.
4. Products:

a. Gripple, Inc; Universal Bracket: www.gripple.com/#sle.
b. Gripple, Inc; Universal Clamp (Threaded): www.gripple.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.

D. Cable Supports: Suitable for cables to be supported, including but not limited to J-hooks, bridle rings, drive rings, and flexible harnesses/slings.
1. Manufacturers:
a. Eaton Corporation: www.eaton.com/#sle.
b. nVent; Caddy: www.nvent.com/#sle.
c. Panduit: www.panduit.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.
2. Applications:
a. Do not exceed 5 feet between cable supports.
b. Maximum Number of Cables per Cable Support:
1) J-Hooks: 50, regardless of capacity.

c. Allowable Cable Types:
1) J-Hooks: Category 3, Category 5e, Category 6, and Category 6A.

2) Bridle Rings without Saddle: Category 3.

3) Bridle Rings with Saddle: Category 3, Category 5e, Category 6, and Category 6A.

3. Comply with TIA-569.
4. Cable Supports Installed in Spaces Used for Environmental Air: Plenum rated; listed and labeled as complying with UL 2043, suitable for use in air-handling spaces.
5. J-Hooks: Noncontinuous cabling support with removable top retainer clip.
a. Material: Use galvanized steel, factory-painted steel, or stainless steel.
b. Provide support surfaces with smooth, beveled edges and radius not less than minimum allowable bend radius of cables supported.
c. Provide multitiered J-hooks where required to support multiple cabling systems.
d. Color coding to be visible from below after installation.
6. Bridle rings: Noncontinuous circular cabling support.
a. Material: Use galvanized steel, painted steel, or stainless steel.
b. Provide integral saddle with smooth, beveled edges and radius not less than minimum allowable bend radius of cables supported where indicated.
7. Products:
a. Gripple, Inc; Fast Trak J-Hook: www.gripple.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

E. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
1. Manufacturers:
a. ABB: www.electrification.us.abb.com/#sle.
b. Eaton Corporation: www.eaton.com/#sle.
c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.

F. Metal Channel/Strut Framing Systems:
   1. Manufacturers:
      a. ABB: www.electrification.us.abb.com/#sle.
      b. Atkore International Inc; Unistrut: www.unistrut.us/#sle.
      c. Eaton Corporation: www.eaton.com/#sle.
      d. Substitutions: See Section 016000 - Product Requirements.
      e. Source Limitations: Furnish channel/strut and associated fittings, accessories, and hardware produced by single manufacturer.
   2. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
   3. Comply with MFMA-4.
   4. Channel/Strut Used as Raceway, Where Indicated: Listed and labeled as complying with UL 5B.
   5. Channel Material:
      a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
   6. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
   7. Minimum Channel Dimensions: 1-5/8 inch wide by 13/16 inch high.

G. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
   1. Minimum Size, Unless Otherwise Indicated or Required:
      a. Equipment Supports: 1/2-inch diameter.
      b. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch diameter.
      c. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch diameter.
      d. Trapeze Support for Multiple Conduits: 3/8-inch diameter.
      e. Outlet Boxes: 1/4-inch diameter.

H. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
   1. Manufacturers:
      a. Atkore International Inc; Unistrut: www.unistrut.us/#sle.
      b. Eaton Corporation: www.eaton.com/#sle.
      c. nVent; Caddy: www.nvent.com/#sle.
      d. PHP Systems/Design: www.phpsd.com/#sle.
      e. Substitutions: See Section 016000 - Product Requirements.
   2. Description: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring attachment to roof structure and not penetrating roofing assembly, with support fixtures as specified.
   3. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
   4. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
   5. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

I. Anchors and Fasteners:

1. Manufacturers - Mechanical Anchors:
   a. Dewalt: anchors.dewalt.com/#sle.
   b. Hilti, Inc: www.hilti.com/#sle.
   c. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
   d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
   e. Substitutions: See Section 016000 - Product Requirements.
2. Manufacturers - Powder-Actuated Fastening Systems:
   a. Dewalt: anchors.dewalt.com/#sle.
   b. Hilti, Inc: www.hilti.com/#sle.
   c. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com/#sle.
   d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
   e. Substitutions: See Section 016000 - Product Requirements.
3. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
4. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
6. Hollow Masonry: Use toggle bolts.
7. Hollow Stud Walls: Use toggle bolts.
8. Steel: Use beam clamps, machine bolts, or welded threaded studs.
9. Sheet Metal: Use sheet metal screws.
10. Wood: Use wood screws.
11. Plastic and lead anchors are not permitted.
12. Hammer-driven anchors and fasteners are not permitted.
13. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
    a. Manufacturer: Same as manufacturer of metal channel/strut framing system.
    b. Comply with MFMA-4.
    c. Channel Material: Use galvanized steel.
    d. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
14. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install hangers and supports in accordance with NECA 1, BICSI ITSIMM, and BICSI N1.

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

E. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.

G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Provide required seismic controls.

I. Field Welding, Where Approved by Engineer: See Section 055000.

J. Equipment Support and Attachment:
   1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
   2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

K. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

L. Secure fasteners in accordance with manufacturer's recommended torque settings.

M. Remove temporary supports.

N. Identify independent communications component support wires above accessible ceilings, where permitted, with color distinguishable from other support wires in accordance with NFPA 70.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 270529

SECTION 270533.13 - CONDUIT FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Stainless steel rigid metal conduit (RMC).

C. Aluminum rigid metal conduit (RMC).

D. Galvanized steel intermediate metal conduit (IMC).

E. Stainless steel intermediate metal conduit (IMC).

F. PVC-coated galvanized steel rigid metal conduit (RMC).

G. Flexible metal conduit (FMC).

H. Liquidtight flexible metal conduit (LFMC).

I. Galvanized steel electrical metallic tubing (EMT).

J. Stainless steel electrical metallic tubing (EMT).

K. Aluminum electrical metallic tubing (EMT).

L. Rigid polyvinyl chloride (PVC) conduit.

M. Electrical nonmetallic tubing (ENT).

N. Liquidtight flexible nonmetallic conduit (LFNC).

O. Reinforced thermosetting resin conduit (RTRC).

P. High-density polyethylene (HDPE) conduit.

Q. Polyvinyl chloride (PVC) plastic utilities duct.

R. Inside-plant flexible nonmetallic communications raceway/innerduct.

1.2 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

1.3 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC) 2020.

B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S) 2020.

C. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A) 2020.

D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit 2018.

E. ASTM D1002 - Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal) 2010 (Reapproved 2019).

F. ASTM D1598 - Standard Test Methods for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure 2021.

G. ASTM D1599 - Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings 2018.

H. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing 2020.

I. ASTM D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing 2016.

J. ASTM F512 - Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation 2019.

K. ASTM F1055 - Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing 2016a.

L. ASTM F2160 - Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD) 2016.

M. ASTM F2176 - Standard Specification for Mechanical Couplings Used on Polyethylene Conduit, Duct and Innerduct 2017.

N. BICSI ITSIMM - Information Technology Systems Installation Methods Manual (ITSIMM), 8th Edition 2022.

O. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition 2019.

P. BICSI TDMM - Telecommunications Distribution Methods Manual, 14th Edition 2020.

Q. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

R. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT) 2020.

S. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit 2004.

T. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC) 2017.

U. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable 2014.

V. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit 2018.

W. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit 2020.

X. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing 2021.

Y. NEMA TC 6&8 - Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installations 2020.

Z. NEMA TC 7 - Solid-Wall Coilable and Straight Electrical Polyethylene Conduit 2021.

AA. NEMA TC 9 - Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation 2020.

BB. NEMA TC 13 - Electrical Nonmetallic Tubing (ENT) 2014 (Reaffirmed 2019).

CC. NEMA TC 14 (SERIES) - Reinforced Thermosetting Resin Conduit and Fittings Series 2015.

DD. NEMA TC 14.AG - Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings 2015 (Reaffirmed 2021).

EE. NEMA TC 14.BG - Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings 2015 (Reaffirmed 2020).

FF. NEMA TC 14.XW - Extra Heavy Wall Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings 2015 (Reaffirmed 2021).

GG. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

HH. TIA-568.0 - Generic Telecommunications Cabling for Customer Premises 2020e.

II. TIA-569 - Telecommunications Pathways and Spaces 2019e.

JJ. UL 1 - Flexible Metal Conduit Current Edition, Including All Revisions.

KK. UL 6 - Electrical Rigid Metal Conduit-Steel Current Edition, Including All Revisions.

LL. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel Current Edition, Including All Revisions.

MM. UL 360 - Liquid-Tight Flexible Metal Conduit Current Edition, Including All Revisions.

NN. UL 514A - Metallic Outlet Boxes Current Edition, Including All Revisions.

OO. UL 514B - Conduit, Tubing, and Cable Fittings Current Edition, Including All Revisions.

PP. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings Current Edition, Including All Revisions.

QQ. UL 651A - Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit Current Edition, Including All Revisions.

RR. UL 746C - Polymeric Materials – Use in Electrical Equipment Evaluations Current Edition, Including All Revisions.

SS. UL 797 - Electrical Metallic Tubing-Steel Current Edition, Including All Revisions.

TT. UL 797A - Electrical Metallic Tubing - Aluminum and Stainless Steel Current Edition, Including All Revisions.

UU. UL 1242 - Electrical Intermediate Metal Conduit-Steel Current Edition, Including All Revisions.

VV. UL 1653 - Electrical Nonmetallic Tubing Current Edition, Including All Revisions.

WW. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit Current Edition, Including All Revisions.

XX. UL 2024 - Standard for Cable Routing Assemblies and Communications Raceways Current Edition, Including All Revisions.

YY. UL 2419 - Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds Current Edition, Including All Revisions.

ZZ. UL 2420 - Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings Current Edition, Including All Revisions.

AAA. UL 2515 - Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings Current Edition, Including All Revisions.

BBB. UL 2515A - Standard for Supplemental Requirements for Extra Heavy Wall Reinforced Thermosetting Resin Conduit (RTRC) and Fittings Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate minimum sizes of conduits with actual type and quantity of cables to be installed.
2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
5. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not begin installation of communications cables until installation of conduit between termination points is complete.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

C. Shop Drawings:
1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
2. Include proposed locations of roof penetrations and methods for sealing.

D. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2-inch (53 mm) trade size and larger.

1.6 QUALITY ASSURANCE

A. Documents at Project Site: Maintain at project site one copy of manufacturer's instructions and shop drawings.

B. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.

B. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, TIA-569, BICSI ITSIMM, BICSI TDMM, manufacturers' instructions, and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:
   1. Under Slab on Grade: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), galvanized steel electrical metallic tubing (EMT), stainless steel electrical metallic tubing (EMT), rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
   2. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), galvanized steel electrical metallic tubing (EMT), stainless steel electrical metallic tubing (EMT), rigid PVC conduit, reinforced thermosetting resin conduit (RTRC), or high-density polyethylene (HDPE) conduit.
   3. Where rigid polyvinyl chloride (PVC) conduit or high-density polyethylene (HDPE) conduit is provided, transition to galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), galvanized steel electrical metallic tubing (EMT), stainless steel electrical metallic tubing (EMT), or schedule 80 rigid PVC conduit where emerging from underground.
   4. Where rigid polyvinyl chloride (PVC) conduit larger than 2-inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit (RMC) elbows, stainless steel rigid metal conduit (RMC) elbows, galvanized steel intermediate metal conduit (IMC) elbows, stainless steel intermediate metal conduit (IMC) elbows, PVC-coated galvanized steel rigid metal conduit (RMC) elbows, or concrete-encased PVC elbows for bends.

5. Where galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC) is installed in direct contact with earth where soil has resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection.
6. Where galvanized steel electrical metallic tubing (EMT) is installed in direct contact with earth, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection.
7. Where aluminum rigid metal conduit (RMC) or aluminum electrical metallic tubing (EMT) is installed in direct contact with earth, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection.
8. Where galvanized rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or galvanized steel electrical metallic tubing (EMT) emerges from concrete into soil, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection for minimum of 4 inches on either side of where conduit emerges.

D. Embedded Within Concrete:
1. Within Slab on Grade: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), galvanized steel electrical metallic tubing (EMT), rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC). Embed within structural slabs only where approved by Structural Engineer.
2. Within Slab Above Ground: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), galvanized steel electrical metallic tubing (EMT), rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC). Embed within structural slabs only where approved by Structural Engineer.
3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), galvanized steel electrical metallic tubing (EMT), rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
4. Where rigid polyvinyl chloride (PVC) conduit is provided, transition to galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), or galvanized steel electrical metallic tubing (EMT) where emerging from concrete.

5. Where galvanized steel electrical metallic tubing (EMT) emerges from concrete into salt air, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection for minimum of 4 inches on either side of where conduit emerges.
6. Where aluminum rigid metal conduit (RMC) and aluminum electrical metallic tubing (EMT) is installed in concrete, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection.

E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), stainless steel electrical metallic tubing (EMT), or inside-plant flexible nonmetallic communications raceway/innerduct.

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), stainless steel electrical metallic tubing (EMT), or schedule 80 rigid PVC conduit.
1. Locations subject to physical damage include, but are not limited to:
    a. Where exposed below 8 feet, except within electrical and communication rooms or closets.

K. Exposed, Interior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or stainless steel intermediate metal conduit (IMC).
   1. Locations subject to severe physical damage include, but are not limited to:
      a. High traffic industrial and warehouse areas where exposed below 8 feet, except within electrical and communication rooms or closets.

L. Exposed, Exterior, Not Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

M. Exposed, Exterior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or stainless steel intermediate metal conduit (IMC).

N. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

O. Corrosive Locations Above Ground: Use stainless steel rigid metal conduit (RMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), stainless steel electrical metallic tubing (EMT), or reinforced thermosetting resin conduit (RTRC).
   1. Corrosive locations include, but are not limited to:

P. Flexible Connections to Vibrating Equipment:
   1. Dry Locations: Use flexible metal conduit.
   2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
   3. Maximum Length: 6 feet unless otherwise indicated.
   4. Vibrating equipment includes, but is not limited to:
      a. Motorized equipment.

Q. Fished in Existing Walls, Where Necessary: Use flexible metal conduit (FMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

2.2 CONDUIT - GENERAL REQUIREMENTS

A. Comply with NFPA 70 and TIA-569.

B. Provide conduit, fittings, supports, and accessories required for complete communications pathway.

C. Provide products listed, classified, and labeled as suitable for purpose intended.

D. Maximum Number of Communications Outlet Boxes per Continuous Conduit Homerun: Two.

E. Minimum Conduit Size, Unless Otherwise Indicated:
1. Communications Outlet Box: 3/4-inch trade size.
2. Continuous Conduit Homerun Serving One Communications Outlet Box: 1-inch trade size.
3. Continuous Conduit Homerun Serving Two Communications Outlet Boxes: 1-inch trade size.

F. Where conduit size is not indicated, size to comply with NFPA 70, TIA-569, and BICSI TDMM, but not less than applicable minimum size requirements specified. Where specified standards differ, comply with most stringent.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:
1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
2. Nucor Tubular Products: www.nucortubular.com/#sle.
3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:
1. Manufacturers:
a. ABB; T&B: www.electrification.us.abb.com/#sle.
b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
c. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
e. Substitutions: See Section 016000 - Product Requirements.
2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
3. Material: Use steel or malleable iron.
a. Where not subject to severe corrosive influence, stainless steel or aluminum fittings may be used.
b. Do not use die cast zinc fittings.
4. Connectors and Couplings: Use threaded fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.
5. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.
a. Manufacturers:
1) Madison Electric Products, a division of Southwire Company: www.meproducts.net/#sle.

2) Substitutions: See Section 016000 - Product Requirements.

b. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.4 STAINLESS STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:
1. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
2. Gibson Stainless & Specialty, Inc: www.gibsonstainless.com/#sle.
3. Patriot Industries, a division of Patriot Aluminum Products, LLC: www.patriotsas.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type RMC stainless steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6A.
1. Material: Type 304 or 316 stainless steel.

C. Fittings:
1. Manufacturers:
a. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
b. Eaton: www.eaton.com/#sle.
c. Gibson Stainless & Specialty, Inc: www.gibsonstainless.com/#sle.
d. Patriot Industries, a division of Patriot Aluminum Products, LLC: www.patriotsas.com/#sle.
e. Substitutions: See Section 016000 - Product Requirements.
2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A.
3. Material: Use stainless steel with corrosion resistance equivalent to conduit.
4. Connectors and Couplings: Use threaded fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.
5. Conduit Bodies: Standard conduit bodies designed for electrical raceways are not permitted.

2.5 ALUMINUM RIGID METAL CONDUIT (RMC)

A. Manufacturers:
1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
2. Nucor Tubular Products: www.nucortubular.com/#sle.
3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.

C. Fittings:
1. Manufacturers:

a. ABB; T&B: www.electrification.us.abb.com/#sle.
b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
c. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
e. Substitutions: See Section 016000 - Product Requirements.

2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A
3. Material: Use aluminum.
4. Connectors and Couplings: Use threaded fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.
5. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.
   a. Manufacturers:
   b. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.6 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:
1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
2. Nucor Tubular Products: www.nucortubular.com/#sle.
3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

C. Fittings:
1. Manufacturers:
   a. ABB; T&B: www.electrification.us.abb.com/#sle.
   b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
   c. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
   d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
   e. Substitutions: See Section 016000 - Product Requirements.
2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
3. Material: Use steel or malleable iron.
4. Connectors and Couplings: Use threaded fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.
5. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.
   a. Manufacturers:
      1) Madison Electric Products, a division of Southwire Company: www.meproducts.net/#sle.

      2) Substitutions: See Section 016000 - Product Requirements.

b. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.7 STAINLESS STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:
1. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
2. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

C. Fittings:
1. Manufacturers:
a. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
b. Eaton: www.eaton.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.
2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
3. Material: Use stainless steel with corrosion resistance equivalent to conduit.
4. Connectors and Couplings: Use threaded fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.
5. Conduit Bodies: Standard conduit bodies designed for electrical raceways are not permitted.

2.8 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:
1. ABB; Ocal: www.electrification.us.abb.com/#sle.
2. Calbond, a division of Atkore International www.calbond.com/#sle
3. Robroy Industries: www.robroy.com/#sle.

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.

C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil, 0.040 inch.

D. Interior Coating: Urethane, minimum thickness of 2 mil, 0.002 inch.

E. PVC-Coated Boxes and Fittings:
1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
2. Nonhazardous Locations: Use boxes and fittings listed and labeled as complying with UL 514A, UL 514B, or UL 6.
3. Material: Use steel or malleable iron.
4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil, 0.040 inch.
5. Interior Coating: Urethane, minimum thickness of 2 mil, 0.002 inch.

6. Conduit Bodies: Standard conduit bodies designed for electrical raceways are not permitted.

F. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil, 0.015 inch.

2.9 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:
1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
2. Electri-Flex Company: www.electriflex.com/#sle.
3. International Metal Hose: www.metalhose.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.

C. Fittings:
1. Manufacturers:
a. ABB; T&B: www.electrification.us.abb.com/#sle.
b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
4. Conduit Bodies: Standard conduit bodies designed for electrical raceways are not permitted.

2.10 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:
1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
2. Electri-Flex Company: www.electriflex.com/#sle.
3. International Metal Hose: www.metalhose.com/#sle.

B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:
1. Manufacturers:
a. ABB; T&B: www.electrification.us.abb.com/#sle.
b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

3. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.
4. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.
   a. Manufacturers:
      1) Madison Electric Products, a division of Southwire Company: www.meproducts.net/#sle.

   b. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.11 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
   1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
   2. Nucor Tubular Products: www.nucortubular.com/#sle.
   3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
   4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
   5. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Fittings:
   1. Manufacturers:
      a. ABB; T&B: www.electrification.us.abb.com/#sle.
      b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
      c. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
      d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
      e. Substitutions: See Section 016000 - Product Requirements.
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Material: Use steel or malleable iron.
      a. Do not use die cast zinc fittings.
   4. Connectors and Couplings: Use compression/gland or set-screw type.
      a. Do not use indenter type connectors and couplings.
   5. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.
   6. Embedded Within Concrete, Where Permitted: Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.
   7. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.
      a. Manufacturers:
         1) Madison Electric Products, a division of Southwire Company: www.meproducts.net/#sle.

         2) Substitutions: See Section 016000 - Product Requirements.

      b. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.12 STAINLESS STEEL ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
   1. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
   2. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type EMT stainless steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797A.
   1. Material: Type 304 or 316 stainless steel.

C. Fittings:
   1. Manufacturers:
      a. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Material: Use stainless steel with corrosion resistance equivalent to conduit.
   4. Connectors and Couplings: Use compression/gland or set-screw type.
   5. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.
   6. Conduit Bodies: Standard conduit bodies designed for electrical raceways are not permitted.

2.13 ALUMINUM ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
   1. American Conduit, a division of Hydro: www.americanconduit.com/#sle.
   2. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type EMT aluminum electrical metallic tubing listed and labeled as complying with UL 797A.

C. Fittings:
   1. Manufacturers:
      a. Arlington Industries: www.aifittings.com/#sle.
      b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
      c. Substitutions: See Section 016000 - Product Requirements.
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; listed for use with aluminum EMT.
   3. Material: Use aluminum.
   4. Connectors and Couplings: Use compression/gland or set-screw type.
      a. Do not use indenter type connectors and couplings.
   5. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.
   6. Embedded Within Concrete, Where Permitted: Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.
   7. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.

a. Manufacturers:
   1) Madison Electric Products, a division of Southwire Company: www.meproducts.net/#sle.

   2) Substitutions: See Section 016000 - Product Requirements.

b. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.14 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Manufacturers:
   1. ABB; Carlon: www.electrification.us.abb.com/#sle.
   2. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
   3. Cantex Inc: www.cantexinc.com/#sle.
   4. Heritage Plastics, a division of Atkore International: www.heritageplastics.com/#sle.
   5. JM Eagle: www.jmeagle.com/#sle.
   6. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage.

C. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
   2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.
   3. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.
      a. Manufacturers:
         1) Madison Electric Products, a division of Southwire Company: www.meproducts.net/#sle.

         2) Substitutions: See Section 016000 - Product Requirements.

      b. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.15 ELECTRICAL NONMETALLIC TUBING (ENT)

A. Manufacturers:
   1. ABB; Carlon: www.electrification.us.abb.com/#sle.
   2. Cantex Inc: www.cantexinc.com/#sle.
   3. IPEX, a division of Aliaxis: www.ipexna.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type ENT electrical nonmetallic tubing complying with NEMA TC 13 and listed and labeled as complying with UL 1653.

C. Fittings:

1. Manufacturer: Same as manufacturer of ENT to be connected.
2. Use solvent-welded type fittings.
3. Solvent-Welded Fittings: Rigid PVC fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; suitable for use with ENT.
4. Snap-on Fittings: Listed and labeled as complying with UL 651.

2.16 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. Manufacturers:
1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
2. Electri-Flex Company: www.electriflex.com/#sle.
3. IPEX, a division of Aliaxis: www.ipexna.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.

C. Fittings:
1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for type of conduit to be connected.

2.17 REINFORCED THERMOSETTING RESIN CONDUIT (RTRC)

A. Manufacturers:
1. Champion Fiberglass, Inc: www.championfiberglass.com/#sle.
2. FRE Composites, a division of Atkore International: www.frecompositesinc.com/#sle.
3. United Fiberglass of America, Inc: www.unitedfiberglass.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Applications:
1. Above Ground, Not Subject to Physical Damage: Use aboveground (AG), SW (Standard Wall), HW (Heavy Wall), or XW (Extra Heavy Wall) RTRC.
2. Above Ground, Subject to Physical Damage: Use aboveground (AG), XW (Extra Heavy Wall) RTRC.
3. Underground, Direct-Buried: Use belowground (BG), DB (direct-burial) RTRC or aboveground (AG) RTRC.
4. Underground, Embedded in Concrete: Use belowground (BG), EB (encased-burial) RTRC, belowground (BG), DB (direct-burial) RTRC, or aboveground (AG) RTRC.

C. Description: NFPA 70, Type RTRC reinforced thermosetting resin conduit complying with NEMA TC 14 (SERIES).
1. Aboveground (AG) RTRC: Comply with NEMA TC 14.AG and list and label as complying with UL 2515.
2. Aboveground (AG), XW (Extra Heavy Wall) RTRC: Comply with NEMA TC 14.XW and list and label as complying with UL 2515A.

3. Belowground (BG) RTRC: Comply with NEMA TC 14.BG and list and label as complying with UL 2420.

D. Supports: As recommended by manufacturer.

E. Fittings: Same type and manufacturer as conduit to be connected.
1. Cement-Tight Joints: Use bonded coupling or bell and spigot.
2. Cement-Tight and Watertight Joints: Use adhesive and manufacturer's standard gaskets.
3. Conduit Bodies: Standard conduit bodies designed for electrical raceways are not permitted.

2.18 HIGH-DENSITY POLYETHYLENE (HDPE) CONDUIT

A. Manufacturers:
1. ABB; Carlon: www.electrification.us.abb.com/#sle.
2. Blue Diamond Industries, LLC: www.bdiky.com/#sle.
3. Eastern Wire + Conduit, a division of Atkore International: www.easternwire.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type HDPE high-density polyethylene solid-wall conduit complying with ASTM F2160 and NEMA TC 7; list and label as complying with UL 651A; Schedule 40 unless otherwise indicated.

C. Joining Methods: Approved by HDPE conduit manufacturer.

D. Mechanical Fittings: Comply with ASTM F2176; list and label as complying with UL 651A.

E. Butt Heat Fusion Fittings: Comply with ASTM D3261.

F. Socket Fusion Fittings: Comply with ASTM D2683.

G. Electrofusion Fittings: Comply with ASTM F1055.

2.19 POLYVINYL CHLORIDE (PVC) PLASTIC UTILITIES DUCT

A. Manufacturers:
1. ABB; Carlon: www.electrification.us.abb.com/#sle.
2. Cantex Inc: www.cantexinc.com/#sle.
3. JM Eagle: www.jmeagle.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: Rigid polyvinyl chloride plastic utilities duct complying with NEMA TC 6&8 and ASTM F512; Type EB-20 listed and labeled as complying with UL 651 suitable for burial with concrete encasement.

C. Fittings: Comply with NEMA TC 9.
1. Manufacturer: Same as manufacturer of duct to be connected.

2.20 INSIDE-PLANT FLEXIBLE NONMETALLIC COMMUNICATIONS RACEWAY/INNERDUCT

A. Manufacturers:
   1. Eastern Wire + Conduit, a division of Atkore International: www.easternwire.com/#sle.
   2. Endot Industries: www.endot.com/#sle.
   3. Premier Conduit: www.premierconduit.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Description: Flexible, corrugated, nonmetallic communications raceway and associated fittings listed and labeled as complying with UL 2024; also suitable for installation as innerduct.

C. Raceway Applications:
   1. Plenum Applications: Use listed plenum raceway.
   2. Riser Applications: Use listed riser or plenum raceway.
   3. General Purpose Applications: Use listed general purpose, riser, or plenum raceway.

D. Use only with approved cables in accordance with listing.

E. Color: Orange, unless otherwise indicated.

2.21 ACCESSORIES

A. Inside-Plant Fabric Innerduct: Listed as complying with UL 2024; plenum rated.

B. Outside-Plant Fabric Innerduct: Designed for installation in underground raceways.

C. Outside-Plant HDPE Innerduct: Smooth interior wall; orange unless otherwise indicated.

D. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil, 0.020 inch.

E. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.

F. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

G. Epoxy Adhesive for RTRC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

H. Adhesive for HDPE and RTRC Conduit:
   1. Specifically designed for bonding dissimilar materials in lieu of transition fittings, including but not limited to polyethylene, fiberglass, PVC, aluminum, and steel; UL 746C recognized.
   2. Approved by adhesive manufacturer for use with materials to be joined.
   3. Adhesive Shear Strength: Not less that 100 psi, when tested in accordance with ASTM D1002.

4. Hydrostatic Pressure Resistance: No leaks, when tested in accordance with ASTM D1598 at 120 psi for 1,000 hours and when tested in accordance with ASTM D1599 at 250 psi.

I. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.

J. Foam Conduit Sealant:
1. Removable, two-part, closed-cell foam, specifically designed for sealing conduit openings against water, moisture, gases, and dust.
2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
3. Rated to hold minimum of 10 ft water head pressure.

K. Sealing Compound for Hazardous/Classified Location Sealing Fittings: Listed for use with particular fittings to be installed.

L. Sealing Systems for Concrete Penetrations:
1. Sleeves: Provide water stop ring or cement coating that bonds to concrete to prevent water infiltration.
2. Rate for minimum of 40 psig; suitable for sealing around conduits to be installed.

M. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.

N. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.

O. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

P. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for conduit/duct arrangement to be installed.

Q. Bore Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for installation within casing; furnished with roller wheels to facilitate installation, openings to facilitate grout flow, and holes for stabilization cable; suitable for casing and conduit/duct arrangement to be installed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install conduit in accordance with NECA 1, BICSI ITSIMM, and BICSI N1.

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.

E. Install galvanized steel intermediate metal conduit (IMC) in accordance with NECA 101.

F. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by manufacturer.

G. Install galvanized steel electrical metallic tubing (EMT) in accordance with NECA 101.

H. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

I. Install electrical nonmetallic tubing (ENT) in accordance with NECA 111.

J. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.

K. Conduit Routing:
   1. Unless dimensioned, conduit routing indicated is diagrammatic.
   2. When conduit destination is indicated without specific routing, determine exact routing required.
   3. Conceal conduits unless specifically indicated to be exposed.
   4. Conduits in the following areas may be exposed, unless otherwise indicated:
      a. Electrical rooms.
      b. Communications rooms.
      c. Mechanical equipment rooms.
      d. Within joists in areas with no ceiling.
   5. Unless otherwise approved, do not route exposed conduits:
      a. Across floors.
      b. Across roofs.
      c. Across top of parapet walls.
      d. Across building exterior surfaces.
   6. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
   7. Arrange conduit to maintain adequate headroom, clearances, and access.

8. Arrange conduit to provide no more than equivalent of two 90-degree bend(s) between pull points.
    a. The equivalent of three 90-degree bends between pull points is permitted only under conditions described in BICSI TDMM.
9. Arrange conduit to provide no more than 100 feet between pull points.
10. Arrange conduit to provide minimum bend radii in accordance with BICSI TDMM.
11. Route conduits above water and drain piping where possible.
12. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
13. Maintain recommended separation from sources of EMI greater than 5 kVA in accordance with BICSI ITSIMM and BICSI TDMM.
14. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
15. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
    a. Heaters.
    b. Hot water piping.
    c. Flues.
16. Group parallel conduits in same area on common rack.

L. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction.
2. Provide required seismic controls.
3. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
4. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
5. Use conduit strap to support single surface-mounted conduit.
    a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
6. Use metal channel/strut with accessory conduit clamps to support multiple, parallel, surface-mounted conduits.
7. Use conduit clamp to support single conduit from beam clamp or threaded rod.
8. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple, parallel, suspended conduits.
9. Use nonpenetrating rooftop supports to support conduits routed across rooftops, where approved.
10. Use of spring steel conduit clips for support of conduits is not permitted.
11. Use of wire for support of conduits is not permitted.
12. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with most stringent requirements.

M. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.

2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Terminate outside-plant entrance conduits at 4 inches above finished floor unless otherwise indicated.
7. Where spare conduits stub up through concrete floors and are not terminated in box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
8. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect cables.
9. Secure joints and connections to provide mechanical strength and electrical continuity.

N. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves and/or slots for penetrations as indicated or as required to facilitate installation.
4. Conceal bends for conduit risers emerging above ground.
5. Provide suitable sealing system where conduits penetrate exterior wall below grade.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
8. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 078400.

O. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
1. Maximum Conduit Size: 1-inch trade size unless otherwise approved.
2. Install conduits within middle one third of slab thickness.
3. Secure conduits to prevent floating or movement during pouring of concrete.

P. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed cables or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.

3. Where calculated in accordance with NFPA 70 for reinforced thermosetting resin conduit (RTRC) conduit installed above ground to compensate for thermal expansion and contraction.
4. Where conduits are subject to earth movement by settlement or frost.

Q. Conduit Sealing:
1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
   a. Where conduits enter building from outside.
   b. Where service conduits enter building from underground distribution system.
   c. Where conduits enter building from underground.
   d. Where conduits may transport moisture to contact live parts.
2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
   a. Where conduits pass from outdoors into conditioned interior spaces.
   b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
3. Where conduits cross boundaries of hazardous/classified locations, provide identified/listed sealing fittings as approved by authorities having jurisdiction; locate as indicated or in accordance with NFPA 70.

R. Provide pull string in each empty conduit and innerduct/cell, and in each conduit where cables are to be installed by others. Leave minimum slack of 12 inches at each end.

S. Provide grounding and bonding.

T. Identify conduits.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.

D. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.5 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of cables.

END OF SECTION 270533.13

SECTION 284600 - FIRE DETECTION AND ALARM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fire alarm system design and installation, including all components, wiring, and conduit.

B. Transmitters for communication with supervising station.

C. Maintenance of fire alarm system under contract for specified warranty period.

1.2 RELATED REQUIREMENTS

A. Section 083323 - Overhead Coiling Doors: Coiling fire doors to be released by fire alarm system.

B. Section 087100 - Door Hardware: Electrically operated locks and door holder devices to be monitored and released by fire alarm system.

C. Section 142100 - Electric Traction Elevators: Elevator systems monitored and controlled by fire alarm system.

D. Section 211300 - Fire-Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.

E. Section 233300 - Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.

1.3 REFERENCE STANDARDS

A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines current edition.

B. ADA Standards - 2010 ADA Standards for Accessible Design 2010.

C. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits 2002 (Corrigendum 2012).

D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. NFPA 72 - National Fire Alarm and Signaling Code Most Recent Edition Cited by Referring Code or Reference Standard.

F. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. NFPA 601 - Standard for Security Services in Fire Loss Prevention 2020.

H. UL 268 - Standard for Smoke Detectors for Fire Alarm Systems Current Edition, Including All Revisions.

I. UL 2034 - Standard for Single and Multiple Station Carbon Monoxide Alarms Current Edition, Including All Revisions.

J. UL 2075 - Standard for Gas and Vapor Detectors and Sensors Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Proposal Documents: Submit the following with cost/time proposal:
1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
2. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
3. Certification by Contractor that the system design will comply with Contract Documents.
4. Proposed maintenance contract.

C. Drawings must be prepared using AutoCAD Release 2010 or later versions.
1. Owner will provide floor plan drawings for Contractor's use; verify all dimensions on Owner-provided drawings.

D. Evidence of designer qualifications.

E. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
1. Copy (if any) of list of data required by authority having jurisdiction.
2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
4. System zone boundaries and interfaces to fire safety systems.
5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
7. List of all devices on each signaling line circuit, with spare capacity indicated.
8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.

10. Detailed drawing of graphic annunciator(s).
11. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
12. Certification by the manufacturer of the control unit that the system design complies with Contract Documents.
13. Certification by Contractor that the system design complies with Contract Documents.

F. Evidence of installer qualifications.

G. Evidence of instructor qualifications; training lesson plan outline.

H. Evidence of maintenance contractor qualifications, if different from installer.

I. Inspection and Test Reports:
1. Submit inspection and test plan prior to closeout demonstration.
2. Submit documentation of satisfactory inspections and tests.
3. Submit NFPA 72 "Inspection and Test Form," filled out.

J. Operating and Maintenance Data: See Section 017800 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
1. Complete set of specified design documents, as approved by authority having jurisdiction.
2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
4. List of recommended spare parts, tools, and instruments for testing.
5. Replacement parts list with current prices, and source of supply.
6. Detailed troubleshooting guide and large scale input/output matrix.
7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.

K. Project Record Documents: See Section 017800 for additional requirements; have one set available during closeout demonstration:
1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
2. "As installed" wiring and schematic diagrams, with final terminal identifications.
3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.

L. Closeout Documents:
1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.

2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
3. Certificate of Occupancy.
4. Maintenance contract.

M. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
1. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.

1.5 QUALITY ASSURANCE

A. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer , with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.

B. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
4. Certified in the State in which the Project is located as fire alarm installer.

C. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.

D. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.6 WARRANTY

A. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.

B. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Fire Alarm Control Units and Accessories:
1. Honeywell Security & Fire Solutions/Gamewell-FCI: www.gamewell-fci.com/#sle.
2. Honeywell Security & Fire Solutions/Fire-Lite: www.firelite.com/#sle.
3. Honeywell Security & Fire Solutions/Notifier: www.notifier.com/#sle.
4. Honeywell Security & Fire Solutions/Silent Knight: www.silentknight.com/#sle.
5. Siemens Building Technologies, Inc: www.usa.siemens.com/#sle.
6. Simplex, a brand of Johnson Controls: www.simplex-fire.com/#sle.
7. Provide control units made by the same manufacturer.

B. Initiating Devices and Notification Appliances:
1. Honeywell Security & Fire Solutions/Gamewell-FCI: www.gamewell-fci.com/#sle.
2. Honeywell Security & Fire Solutions/Fire-Lite: www.firelite.com/#sle.
3. Honeywell Security & Fire Solutions/Notifier: www.notifier.com/#sle.
4. Honeywell Security & Fire Solutions/Silent Knight: www.silentknight.com/#sle.
5. Siemens Building Technologies, Inc: www.sbt.siemens.com/#sle.
6. Simplex, a brand of Johnson Controls: www.simplex-fire.com/#sle.
7. Same manufacturer as control units.
8. Provide initiating devices and notification appliances made by the same manufacturer, where possible.

C. Substitutions: See Section 016000 - Product Requirements.
1. For other acceptable manufacturers of control units specified, submit product data showing equivalent features and compliance with Contract Documents.
2. For substitution of products by manufacturers not listed, submit product data showing features and certification by Contractor that the design will comply with Contract Documents.

2.2 FIRE ALARM SYSTEM

A. Fire Alarm System: Provide a new automatic fire detection and alarm system:
1. Provide all components necessary, regardless of whether shown in Contract Documents or not.
2. Protected Premises: Entire building shown on drawings.
3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
   a. ADA Standards.
   b. The requirements of the State Fire Marshal.
   c. The requirements of the local authority having jurisdiction , which is Town of Bloomfield..
   d. Applicable local codes.

e. Contract Documents (drawings and specifications).
f. NFPA 101.
g. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.

4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
5. Voice Notification: Provide emergency voice/alarm communications with multichannel capability; digital.
6. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
7. Program notification zones and voice messages as directed by Owner.
8. Fire Command Center: Location indicated on drawings.
9. Fire Alarm Control Unit: New, located at fire command center.
10. Two-Way Telephone: Provide two-way telephone service for the use of the fire service and others; provide jacks and two portable handsets.

B. Supervising Stations and Fire Department Connections:
1. Public Fire Department Notification: By on-premises supervising station.
2. On-Premises Supervising Station: Existing proprietary station operated by Owner, located at [_____].
3. Means of Transmission to On-Premises Supervising Station: Directly connected noncoded system.

C. Circuits:
1. Initiating Device Circuits (IDC): Class B, Style A.
2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
3. Notification Appliance Circuits (NAC): Class B, Style W.

D. Spare Capacity:
1. Initiating Device Circuits: Minimum 25 percent spare capacity.
2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
3. Fire Alarm Control Units: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.

E. Power Sources:
1. Primary: Dedicated branch circuits of the facility power distribution system.
2. Secondary: Storage batteries.
3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
4. Each Computer System: Provide uninterruptible power supply (UPS).

2.3 FIRE SAFETY SYSTEMS INTERFACES

A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
1. Sprinkler water control valves.

2. Dry-pipe sprinkler system pressure.
3. Dry-pipe sprinkler valve room low temperature.
4. Elevator shut-down control circuits.
5. CO detectors
    a. Connected as separate zone(s) to building fire alarm signaling system for only a supervisory signal at main panel and remote annunciator(s) (shall not activate the building evacuation alarm)

B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
1. Sprinkler water flow.
2. Kitchen hood suppression activation; also disconnect fuel source from cooking equipment.
3. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.
4. Duct smoke detectors.

C. Elevators:
1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.
2. Elevator Machine Room Heat Detector: Shut down elevator power prior to hoistway sprinkler activation.
3. Sprinkler pressure or waterflow: Shut down elevator power prior to hoistway sprinkler activation.

D. HVAC:
1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.

E. Doors:
1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 087100.
2. Electromagnetic Door Locks on Egress Doors: Unlock upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from. Refer to Section 087100.
3. Overhead Coiling Fire Doors: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 083323.

2.4 COMPONENTS

A. General:
1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.

B. Fire Alarm Control Units: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.

C. Master Control Unit: As shown on the drawings..

D. Remote Annunciators: As shown on the drawings..

E. Addressable Modules:
1. Provide addressable modules suitable for connection to fire alarm control unit signaling line circuits.
2. Unless otherwise indicated, use addressable modules only in clean, dry, indoor, nonhazardous locations.
3. Monitor Modules: Unless devices are explicitly permitted to be connected together as zone, provide separate addressable monitor module for each conventional dry-contact input device in order to be individually identifiable by addressable fire alarm control unit.
4. Control Modules: Provide as indicated or as required for selective control of notification appliances.
5. Releasing Control Modules: Provide as indicated or as required for control of listed solenoids in releasing applications.
6. Relay Modules: Provide as indicated or as required to perform necessary functions via dry-contact interface. Where load exceeds module contact rating, provide accessory power isolation relays suitable for load as required.
7. Signaling Line Circuit (SLC) Isolating Modules: Provide as indicated or as required to automatically isolate short circuits on connected sections of SLC loops and allow other sections to continue to function normally. Provide automatic reset upon correction of short circuit.
8. Products:
   a. Ruskin Company; ADC105 Addressable Damper Controller for Simplex Panels: www.ruskin.com/#sle.
   b. Substitutions: See Section 016000 - Product Requirements.

F. Initiating Devices:
1. Addressable Systems:
   a. Addressable Devices: Individually identifiable by addressable fire alarm control unit.
   b. Provide suitable addressable interface modules as indicated or as required for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
2. Manual Pull Stations:
   a. Provide attic stock of 10% of total quantity shown on plans, plus 4 extra..
3. Smoke Detectors:
   a. Provide attic stock of 10% of total quantity shown on plans, plus 4 extra.
4. Duct Smoke Detectors:
   a. Provide attic stock of 10% of total quantity shown on plans, plus 4 extra.
5. Heat Detectors:
   a. Provide attic stock of 10% of total quantity shown on plans, plus 4 extra.
6. CO Detectors
   a. Meet or exceed UL 2034 .
   b. Meet or exceed UL 2075

G. Notification Appliances:
   1. Bells:
      a. Provide attic stock of 10% of total quantity shown on plans, plus 4 extra.
   2. Speakers:
      a. Provide attic stock of 10% of total quantity shown on plans, plus 4 extra.
   3. Strobes:
      a. Provide attic stock of 10% of total quantity shown on plans, plus 4 extra.

H. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.

I. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.

J. Locks and Keys: Deliver keys to Owner.
   1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type

K. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
   1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
   2. Provide one for each control unit where operations are to be performed.
   3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
   4. Provide extra copy with operation and maintenance data submittal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and Contract Documents.

B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.

C. Obtain Owner's approval of locations of devices, before installation.

D. Install instruction cards and labels.

E. Install CO detectors per manufacturer's instructions, as remotely located from heating appliance as possible, and in accordance with NFPA 720.

F. Provide and install signage for all entry doors to spaces containing both fuel-burning heating equipment and CO detector(s).

3.2 INSPECTION AND TESTING FOR COMPLETION

A. Notify Owner 7 days prior to beginning completion inspections and tests.

B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.

D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.

E. Provide all tools, software, and supplies required to accomplish inspection and testing.

F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.

G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

H. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.
   1. Record all system operations and malfunctions.
   2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
   3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
   4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.3 OWNER PERSONNEL INSTRUCTION

A. Provide the following instruction to designated Owner personnel:
   1. Hands-On Instruction: On-site, using operational system.
   2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
   3. Factory Instruction: At control unit manufacturer's training facility.

B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
   1. Initial Training: 1 session pre-closeout.

C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
   1. Initial Training: 1 session pre-closeout.

D. Detailed Operation: Two-hour sessions for engineering staff; assume NICET level I qualifications or equivalent; combination of classroom and hands-on:

1. Initial Training: 1 session pre-closeout.

E. Maintenance Technicians: Detailed training for electrical technicians, on programming, maintaining, repairing, and modifying; factory training:
   1. Initial Training: One 3-day session, pre-closeout.

F. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.4 CLOSEOUT

A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
   1. Be prepared to conduct any of the required tests.
   2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
   3. Have authorized technical representative of control unit manufacturer present during demonstration.
   4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
   5. Repeat demonstration until successful.

B. Occupancy of the project will not occur prior to Substantial Completion.

C. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
   1. Specified diagnostic period without malfunction has been completed.
   2. Approved operating and maintenance data has been delivered.
   3. Spare parts, extra materials, and tools have been delivered.
   4. All aspects of operation have been demonstrated to Owner.
   5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
   6. Occupancy permit has been granted.
   7. Specified pre-closeout instruction is complete.

3.5 MAINTENANCE

A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.

C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
   1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.

2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
3. Record keeping required by NFPA 72 and authorities having jurisdiction.

D. Provide trouble call-back service upon notification by Owner:
1. Provide on-site response within 2 hours of notification.
2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.

G. Comply with Owner's requirements for access to facility and security.

END OF SECTION 284600

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. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

2. Section 015639 “Temporary Tree and Plant Protection” for protection of existing tree and plant materials to remain.

1.3 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings and indicated according to requirements in Section 015639 "Temporary Tree and Plant Protection.".

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.6 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

B. Topsoil stripping and stockpiling program.

C. Burning: No burning shall be performed.

1.7 QUALITY ASSURANCE

A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

1.8 FIELD 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 trafficways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

D. Utility Locator Service: Notify utility locator service Call Before You Dig for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

F. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."

G. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #23 (surface-tolerant, anticorrosive metal primer) or SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 015639 "Temporary Tree and Plant Protection."

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TREE AND PLANT PROTECTION

A. Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.3 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, 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. Grind down stumps and remove roots larger than 2 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Use only hand methods or air spade for grubbing within protection zones.
4. 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.

3.4 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within protection zones.
3. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.5 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. 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.

B. Burning tree, shrub, and other vegetation waste is not permitted. Burning of other waste and debris is prohibited.

C. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

D. Demolished bituminous asphalt paving is a waste product and shall be removed from the site and legally disposed of.

END OF SECTION 311000

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SECTION 312000 – EARTH MOVING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This section includes the following:

1. Preparing subgrade for foundations, slabs-on-grade, retaining walls, walks, pavements, athletic facilities, lawns, and plantings
2. Excavating and backfilling for buildings and structures
3. Properly managing excavated native soil for reuse on-site
4. Drainage course for slabs-on-grade
5. Structural fill for below footings, slabs, retaining walls, concrete walks, utility pads, and unit pavers, etc. as indicated on the Contract Drawings
6. Subbase and processed aggregate base for bituminous concrete; tennis courts, pavements, pads, etc. as indicated on the Contract Drawings
7. Subbase for curbing and concrete pavement
8. Excavating and backfilling for utility trenches and storm drainage structures
9. Formation of embankment for stormwater management basins

B. Related Sections

a. Section 31 23 19 Dewatering
b. Section 03 30 00 Cast-in-Place Concrete*
c. Section 32 32 23 Segmental Retaining Wall
d. Section 33 10 00 Water Utilities
e. Section 33 40 00 Storm Drainage
f. Section 33 31 00 Sanitary Utility Sewerage
*Per Specifications written by MHA

1.03 DEFINITIONS

A. Fill: General term for soil materials used to raise existing grades.

B. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without pre-approved direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect to address unauthorized excavation, shall be without additional compensation.

C. Backfill: General term used for soil material used to fill an excavation.
   1. Initial Backfill: Backfill placed over excavated subgrade, beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

D. Processed Aggregate Base Course: Course placed between the subbase course and hot-mix asphalt paving, or surface treatment.

E. Bedding Course: Initial Backfill placed over the excavated subgrade in a trench before laying pipe.

F. Structural Fill: Fill of specified quality placed over the excavated subgrade in the building area, within foundation influence (one horizontal : one vertical slope down and away from the edge of structure foundation, plus one foot) exterior foundation wall backfill, support for slabs, retaining walls, pavements, and sidewalks, and outside of the zone of crushed stone backfill.

G. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill per CT DOT Form 818 Section 2.07 and Article 2.02.03.

H. Drainage Course/Crushed Stone: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

I. Common Fill: Fill and backfill placed outside the limits of Structural Fill, Sand and Gravel, and Crushed Stone.

J. Subbase Course: Course placed between the prepared subgrade and base course for hot-mix asphalt pavement, or course placed between the prepared subgrade and a cement concrete or hot-mix asphalt pavement.

K. Athletic Field Base: Course placed between the prepared subgrade and topsoil or synthetic turf in athletic field areas.

L. Subgrade: Surface or elevation remaining after completing excavation.

M. Proof-roll: The application of compactive energy to subgrade for the Geotechnical Engineer's evaluation of suitability of subgrade for bearing.

N. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

O. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

P. Unsatisfactory Soils: Materials including but not limited to the following: soil containing ice, snow, roots, sod, rubbish or other deleterious or organic matter; materials non-conforming to the gradations specified for each soil material and not accepted by the Geotechnical Engineer or Architect; materials with a gradation approved by the Geotechnical Engineer or Architect, but that are too saturated to be reused. For subgrades exposed below new foundations, Unsatisfactory Soils include soils that were placed historically by unnatural methods (by man), and not placed and compacted in a quality-controlled manner with documentation, and native undisturbed materials that are too loose/weak to directly support new loads: it may be possible to reuse these particular

materials through excavation and replacement in compacted, controlled lifts, at the direction of the Geotechnical Engineer.

1.04 PROJECT CONDITIONS

A. Visit the site to review all details of the work and working conditions and to verify dimensions in the field including headroom and interferences from adjacent structures. Notify the Architect in writing of any discrepancy before performing any work.

B. Consult official records of existing utilities, both surface and subsurface, and their connection to be fully informed on all existing conditions and limitations as they apply to this work and its relation to other construction work.

C. 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.

D. Verify that survey benchmark and intended elevations for work are as indicated.

1.05 QUALITY ASSURANCE

A. Workers: all workers shall be thoroughly trained and experienced in the necessary crafts, and completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

B. Form 818 - State of Connecticut Department of Transportation "Specifications for Roads, Bridges, Facilities and Incidental Construction" 2020 edition and latest supplements shall be used for material compliance and execution of the work in this section.

C. Testing and Inspection: Contractor shall employ and pay for a qualified independent laboratory to perform testing and inspection service required by these specifications and in compliance with the specifications outlined in the Form 818 - State of Connecticut Department of Transportation "Specifications for Roads, Bridges, Facilities and Incidental Construction" 2020 and latest supplements.

D. All work shall be in accordance with Geotechnical Engineering Study dated August 31, 2021, revised March 7, 2022 prepared by Langan.

1.06 SUBMITTALS

A. Gradation reports of all fill and construction materials to be used for the project (prior to delivery of any materials). If specified by the Form 818, hardness and recycled content tests shall also be provided.

B. Source of and environmental analysis of any imported topsoil and common fill or borrow

C. Company information on independent testing company

D. Schedule for compaction testing

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations. Materials shall be free from ice, snow, roots, sod, rubbish or other deleterious or organic matter and shall conform to the gradations specified for each soil material.

B. Processed Aggregate Base Course: Course placed below the slab or between the subbase and hot mix asphalt per State of Connecticut Department of Transportation "Specifications for Roads, Bridges, Facilities and Incidental Construction" 2020 edition and latest supplements, Form 818 Article M.05.01 modified as follows:

1. Under Section M.05, 2. Coarse Aggregate, delete the phrase "the coarse aggregate shall not have a loss of more than 50%" and substitute the phrase "the coarse aggregate shall not have a loss of more than 40%".

C. Subbase Course: Course placed between the subgrade and base course per State of Connecticut Department of Transportation "Specifications for Roads, Bridges, Facilities and Incidental Construction" 2020 edition and latest supplements, From 818 Articles M.02.06, Grading A and M.02.06.04 Soundness.

D. Common Fill: General fill and backfill placed outside the limits of Structural Fill, Sand-Gravel, and Crushed Stone. Common Fill shall be friable soil, free of rubbish, ice, snow, tree stumps, roots, and other organic matter; no stone greater than 8 inches and maximum percent finer than No. 200 sieve of 25 percent. Contractor may request to use fill from on-site sources containing more than 25 percent finer than No. 200 sieve; however, optimum moisture contents shall be maintained otherwise the material may be considered unsatisfactory.

E. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe. Bedding Course shall consist of Sand free of silt, clay, loam, and organic matter. Bedding material shall conform to State of Connecticut Department of Transportation "Specifications for Roads, Bridges, Facilities and Incidental Construction" 2020 edition and latest supplements, Form 818 Article M.08.03.

F. Structural Fill: Structural fill should be well-graded sand and gravel having a maximum particle size of 3 inches and no more than 10% passing the No. 200 sieve. Additionally, the structural fill should be free of organics, clay, roots, concrete, other non-soil constituents, and other deleterious or compressible materials. Any approved imported structural fill should be “certified clean fill” free of hazardous substances and meeting all local, state, federal and the Connecticut Department of Energy and Environmental Protection Soil Waste regulations.

G. Material Reuse: The contractor may reuse the sand or glacial till as structural fill provided the soils meet the requirements for structural fill outlined above and is approved by the environmental engineer. Note that samples obtained within the sand and glacial till layers have a fines content (material passing the No. 200 sieve) from about 5% to 32%; therefore, the soil will be sensitive to moisture. The overall amount of soil that can be reused will be dependent on the

amount of fines present within the soil, the time of year the earthwork. is carried out (e.g., potentially inclement weather), and the earthwork contractor's ability to stage, aerate and process the material to facilitate placement and compaction.

H. General Fill: On-site soils not meeting the requirements for structural fill can be used as general fill for site landscape and other nonstructural areas if environmentally suitable for reuse.

I. Crushed Stone: Broken stone or gravel conforming to State of Connecticut Department of Transportation "Specifications for Roads, Bridges, Facilities and Incidental Construction" 2020 edition and latest supplements, Form 818 Article M.01.01 No. 67. In areas where Crushed Stone is placed in a total layer thickness greater than 8 inches, wrap Crushed Stone with Filter Fabric.

J. Sand & Gravel: Well-graded, select angular excavated gravel or processed stone materials free of organic material, loam, trash, snow, ice, frozen soil, and other objectionable material.

Such material shall have characteristics that promote drainage, efficient compaction, provide a stable and predictable bearing surface, and conforms to the following gradation requirement:

K. Crushed Stone: Broken stone or gravel conforming to State of Connecticut Department of Transportation "Specifications for Roads, Bridges, Facilities and Incidental Construction" 2020 edition and latest supplements, Form 818 Article M.01.01 No. 67. In areas where Crushed Stone is placed in a total layer thickness greater than 8 inches, wrap Crushed Stone with Filter Fabric.

L. Sand & Gravel: Well-graded, select angular excavated gravel or processed stone materials free of organic material, loam, trash, snow, ice, frozen soil, and other objectionable material.

Such material shall have characteristics that promote drainage, efficient compaction, provide a stable and predictable bearing surface, and conforms to the following gradation requirement:

Sieve Size	Percent Passing by Weight
2 inches	100
1/2 inch	50 – 85
No. 4	40 – 75
No. 40	10 –35
No. 200	0 – 10

M. Filter Fabric: Conform to State of Connecticut Department of Transportation "Specifications for Roads, Bridges, Facilities and Incidental Construction" 2020 edition and latest supplements, Form 818 Article Section M.08.01, Paragraph 26, non-woven Mirafi 140 Filter Fabric, or approved equivalent.

N. Vapor Retarder
1. Vapor retarder must be placed over the Drainage Course or Crushed Stone and immediately below bottom of slab elevations.
2. Vapor Retarder must have the following qualities:
   a. WVTR less than or equal to 0.006 gr/ft2/hr as tested by ASTM E 96
   b. ASTM E 1745 Class A (Plastics)
3. Vapor Retarder Products
   a. Stego Wrap (15-mil) Vapor Barrier by Stego Industries, LLC, San Juan Capistrano, CA (877) 464-7834 www.stegoindustries.com, or approved equivalent.

4. Vapor Retarder Accessories:
   a. Vapor Retarding Seam Tape
      1) Tape must have the following qualities: Water Vapor Transmission Rate of 0.3 perms or lower by ASTM E 96.
   b. Vapor Proofing Mastic
      1) Mastic must have the following qualities: Water Vapor Transmission Rate of 0.3 perms or lower by ASTM E 96.
   c. Pipe Boots
      1) Construct pipe boots from vapor barrier material, pressure sensitive tape and/or mastic per manufacturer's instructions.

ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility.

PART 3 - EXECUTION

3.01 PREPARATION

A. Identify and flag structures, utilities, sidewalks, pavements, and other facilities and protect from damage caused by settlement, lateral movement, undermining, washout, impact, and other hazards created by earthwork operations. Maintain and protect existing utilities remaining which pass through work area.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing".

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Site Clearing" during earthwork operations.

3.02 REMOVING EXISTING PAVEMENT SURFACES

1. No excavation shall be made until existing paved surfaces have been neatly saw-cut. Pavement, which is weakened or destroyed beyond the limits indicated, shall be re-cut and trimmed.

2. All pavement removal within state highways shall be in strict accordance with all requirements of the DOT and Town Department of Public Works. Conditions of permits for excavation within established rights-of-way shall be strictly observed and the Contractor shall assume full responsibility for violations thereof.

3.03 SITE CONTAMINATION

1. The suspicion of, or unanticipated discovery of, contaminated ground during the excavation, or other work task under this contract, shall be reported immediately to the

Construction Manager or Owner. The Contractor, at all times, shall exercise caution to protect workmen, observers, and residents from harm. The Contractor shall provide all reasonable and necessary assistance to ascertain the nature and source of ground contamination.

3.04 EXCAVATION, GENERAL

A. Prior to any excavations, groundwater elevations shall be evaluated based on the geotechnical engineering report and actual site conditions. Well points and curtain drains shall be installed as necessary for excavations to be performed above ground water elevations.

B. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered within a tolerance of plus or minus 1 inch. Unclassified excavated materials may include rock and obstructions. Provide additional excavation to reach acceptable subgrade as required by the Geotechnical Engineer (refer to report entitled "Geotechnical Engineering Report – Westside Elementary School"). No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of Unsatisfactory Soils or obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

C. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

3.05 EXCAVATION FOR STRUCTURES

A. Prior to excavations, groundwater elevations shall be evaluated based on the geotechnical engineering report and actual site conditions. Well points and curtain drains shall be installed as necessary for excavations to be performed above ground water elevations.

B. Within building area, and to proper lateral limits, remove all unsuitable materials (i.e., man-placed fill, topsoil, subsoil, or any other deleterious materials) and replace these unsuitable soils with compacted structural fill.

C. Excavate to required elevations and dimensions regardless of the character of surface and subsurface conditions encountered within a tolerance of plus or minus 1 inch. The bottom of all exterior footings shall be at least 42 inches below finished exterior grade. The Contractor shall be responsible for the coordination of the bottom of exterior footing elevations with the finish grades to achieve the 42-inch burial depth for frost protection. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

D. Unsatisfactory Soils are expected to be encountered that will require over-excavation to reach acceptable subgrades. Where Unsatisfactory Soils are encountered when reaching the design lines and grades, the Contractor shall conduct over-excavation after approval by the Geotechnical Engineer or Architect. Such additional excavation shall be continued until encountering acceptable suitable subgrades, as directed by the Geotechnical Engineer or Architect. Excavation of Unsatisfactory Soils encountered at footing and slab subgrade depths shall extend a lateral

distance on all sides that is equal to one-foot plus the depth of excavation below the footing or slab subgrade elevation from the footing or slab edge. The presence of Unsatisfactory Soils are discussed in the Geotechnical Report.

E. Excavations for Footings and Foundations: Excavate to 3 inches below footing and foundation subgrade elevations. Do not disturb bottom of excavation following preparation of the exposed subgrades. Excavate using a smooth-edge bucket or by hand to final grade and proof-roll exposed subgrade as necessary to recompact materials disturbed by excavation. Place crushed stone to bottom of footing and foundation subgrade elevations, providing a working mat to receive other work without disturbance.

F. Footing subgrades shall consist of densified undisturbed native glacial till soil or compacted structural fill placed above densified undisturbed native glacial till soil.

If at footing subgrade depth, acceptable undisturbed native glacial till soils are present, proof-roll the surface for footing subgrade preparation in accordance with Section 3.4 of this Section. If at footing subgrade depth, existing fill or disturbed native glacial till soils are encountered, existing fill or disturbed glacial till soils shall be over-excavated to expose undisturbed native glacial till soil and be replaced with controlled compacted Structural Fill. The exposed undisturbed native glacial till soil shall be proof-rolled in accordance with Section 3.4 of this Section prior to placement of fill or backfill soils. Footing subgrades shall be over-excavated by 3 inches and 3 inches of compacted Crushed Stone shall be replaced and compacted back up to the footing subgrade to provide direct support of footings that will provide a surface less sensitive to strength loss from moisture.

G. Excavations for slab subgrade: Building slabs located in net cut areas shall be supported directly on 12 inches of compacted Crushed Stone underlain by filter fabric over suitable prepared subgrades.

If at slab subgrade depth acceptable undisturbed native glacial till soils is present, proof-roll the acceptable undisturbed native glacial till soils surface for slab subgrade preparation in accordance with Section 3.4 of this Section. If at slab subgrade depth existing fill soils or disturbed native glacial till soils are encountered, notify the Geotechnical Engineer to assess suitability of the material to remain in place below slabs, or over-excavate the existing fill or disturbed native glacial till soils (with approval from the Geotechnical Engineer and Architect) to expose acceptable undisturbed native glacial till soils and replace with controlled compacted Structural Fill. The Geotechnical Engineer shall determine whether existing fill or disturbed native glacial till soils are suitable to remain in place below floor slabs. The exposed suitable subgrades shall be proof-rolled in accordance with Section 3.4 of this Section prior to placement of fill or backfill soils.

Where a net fill is required to reach slab subgrades, on-site native soils may be reused as common fill with approval by the Geotechnical Engineer or Architect to construct a subgrade to an elevation that is 12 inches below the bottom of the slab, followed by installation of 12 inches of compacted Processed Aggregate Base Course.

H. Excavations for pavement subgrade: Pavement section subgrades shall consist of densified undisturbed native glacial till soils, densified existing fill or densified disturbed native glacial till that are approved by the Geotechnical Engineer, or Structural Fill (or approved native soil Common Fill) placed above these materials. If at pavement section subgrade depth, acceptable undisturbed native glacial till soils are present, proof-roll the surface for pavement section

subgrade preparation in accordance with Section 3.4 of this Section. If at pavement section subgrade depth, existing fill or disturbed native glacial till soils are encountered, notify the Geotechnical Engineer to assess suitability of the material to remain in place below pavements, or over-excavate the existing fill or disturbed native glacial till soils (with approval from the Geotechnical Engineer and Architect) to expose acceptable undisturbed native glacial till soils and replace with controlled compacted Structural Fill. The Geotechnical Engineer shall determine whether existing fill or disturbed native glacial till soils are suitable to remain in place below pavement subgrade. The resulting suitable subgrades shall be proof-rolled in accordance with Section 3.4 of this Section prior to placement of fill or backfill soils.

1. If pavement subgrade is undisturbed native glacial till, suitably dense and sufficiently above the groundwater table, prepare the subgrade in accordance with Section 3.4 of this Section.
2. If pavement subgrade has been excavated and replaced with compacted Structural Fill, prepare the subgrade in accordance with Section 3.4 of this Section.
3. If pavement subgrade is existing fill that contains organic or otherwise deleterious material, over-excavate the unsuitable existing fill to the top of undisturbed native glacial till soils, or existing fill that is specifically approved by the Geotechnical Engineer and replace with compacted Structural Fill to achieve pavement section subgrade elevation. The exposed suitable subgrades shall be proof-rolled in accordance with Section 3.4 of this Section prior to placement of fill or backfill soils.
4. If pavement subgrade is disturbed native glacial till or suitable inorganic existing fill, notify the Geotechnical Engineer for assessment of the subgrade. Under the direction of the Geotechnical Engineer or Architect, prepare the subgrade in accordance with the following:
    a. If the disturbed native glacial till or suitable inorganic existing fill thickness is less than or equal to 24 inches and can be densified under ideal moisture conditions, prepare the subgrade in accordance with Section 3.4 of this Section.
    b. If the disturbed native glacial till or suitable inorganic existing fill thickness is less than or equal to 24 inches and is densified under less than ideal moisture conditions, increase the Subbase Course thickness by at least 100 percent and/or install a geosynthetic reinforcement layer (alternative selection to be determined by the Geotechnical Engineer or Architect).

I. Excavation for walkway subgrades: Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

J. Excavation for utility trenches:

1. Excavate trenches to indicated gradients, lines, depths, and elevations.
2. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

3.06 SUBGRADE EVALUATION AND PREPARATION

A. The Geotechnical Engineer must be present for subgrade evaluation. Notify the Geotechnical Engineer at minimum 5 days prior to subgrade preparation.

B. The Geotechnical Engineer shall observe the reaction of the subgrade during proof-rolling and evaluate suitability for foundation bearing. Proof-roll subgrade with six passes (three each way) of a vibratory drum roller weighing at least 20,000 pounds at the drum in open areas, or a 2,000 pound vibratory roller or large plate compactor in trenches to identify soft pockets and areas of excess yielding. Soft pockets and zones of excess yielding shall be excavated and proof-rolled again. Do not proof-roll wet or saturated subgrades. Proof-rolling shall be performed statically at the direction of the Geotechnical Engineer where vibratory methods are not suitable due to groundwater presence or excess soil moisture.

C. Preparation of subgrade operations is to be performed in conditions free of mud, excessive moisture, frost, snow and ice. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation or change in Contract Time. Protect prepared subgrades from damage or strength loss.

D. Prior to the commencement of subgrade preparation, the Geotechnical Engineer shall be notified of any potential Unsatisfactory Soil conditions and a determination made as to the acceptable nature of the subgrade soils.

3.06 UNAUTHORIZED EXCAVATION

A. Backfill unauthorized excavation under foundations or wall footings with Structural Fill or Crushed Stone as directed by the Geotechnical Engineer. Structural Fill placed in unauthorized excavations shall be placed below the limits defined by the 1 horizontal to 1 vertical lines extending downward and outward from a distance starting 1 feet from the bottom outside edge of foundations or wall footings, to the top of proof-rolled subgrades approved by the Geotechnical Engineer. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used in lieu of Structural Fill or Crushed Stone when approved by Architect, without additional compensation or change in Contract Time.

B. Backfill unauthorized excavations under other construction or utility pipe as directed by the Geotechnical Engineer or Architect without additional compensation or change in Contract Time.

3.07 STORAGE OF SOIL MATERIALS AND PROTECTION OF SUBGRADE

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Keep materials suitable for reuse separate from Unsatisfactory Soils. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust and for protection from precipitation.

B. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area by implementing proper water removal systems, diversions, and erosion and sedimentation controls.

C. Do not allow water to accumulate in excavations. Control water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Maintain groundwater at least two feet below excavations during earthwork activities.

D. Slope bottom of excavations to promote routing of precipitation away from footing subgrades.

E. Diligently protect subgrades from becoming disturbed by equipment. Excavate disturbed subgrade and backfill in accordance with specifications at Contractor's expense.

F. During the excavation of soil and all other materials required to accommodate building foundations, slabs, paving and site structures, and construction operations, segregate materials for reuse according to the Geotechnical Engineer.

G. Do not excavate to full depth when freezing temperatures may be expected unless subgrade is protected from freezing or footings or slabs can be placed immediately after excavation is completed and are protected from freezing.

H. Maintain safe and stable excavation sidewalls and slopes in accordance with Occupational Safety and Health Administration requirements.

I. Excavate in a manner that will not disturb existing foundations. Plans for excavating near existing foundations shall be submitted to the Architect for approval prior to beginning such excavation.

J. Correct unauthorized excavations at no additional cost to the Owner or change in Contract Time.

K. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees or within locations of concentrated stormwater runoff.

L. If necessary, insulate backfill materials to prevent the formation of frozen clods that would otherwise render the backfill unusable.

3.08 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Place and compact initial backfill of subgrade material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

D. Place and compact final backfill of satisfactory soil to final subgrade elevation.

E. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.09 SOIL REUSE

A. The inorganic native soils will be suitable for reuse as Common Fill provided the soils intended for reuse are properly managed, stockpiled, protected, dried, moisture conditioned, etc., in order to facilitate achievement of efficient and adequate compaction during replacement.

B. Soil gradation characteristics will likely change slightly with depth and location across the site. While most of the geotechnical data recovered and presented in the Geotechnical Report indicates relatively consistent gradation, the significance of changes encountered shall be evaluated in the field by the Contractor in conjunction with the Geotechnical Engineer to confirm that reuse is acceptable and whether special compaction is warranted, such as the use of sheeps-foot rollers.

C. The native glacial till soils contain a relatively high percentage of finer-grained material, including fine sand and silt, as indicated in the Geotechnical Report. In general, this characteristic can make these soils susceptible to being difficult to reuse after they reach a moisture content greater than optimum. Reuse of silty soils will, therefore, require careful management of the materials by the Contractor to preserve the material structural characteristics to maximize their reuse potential.

D. On-site soils that do not meet Structural Fill or other structural soil gradation (required gradation dependent on intended future use) shall not be reused as fill or backfill as follows:

1. Within the bearing zone of interior or exterior footings.
2. As backfill directly against exterior foundations unless gradation analysis indicates the material to be well draining.
3. As backfill directly against retaining walls unless gradation analysis indicates the material to be well draining.
4. Within the structural fill zone behind mechanically stabilized earth retaining walls unless the materials meets the Structural Fill gradation specification.
5. Where grading is such that infiltration of runoff could create a localized frost penetration issue that would be undesirable.
6. Anywhere other than non-sloping landscape fill areas when the soils contain organics, large particles, frozen materials, or other deleterious constituents.
7. If the moisture content has rendered it unusable for the acceptable reuse options per the judgment of the on-site Geotechnical Engineer.

E. The Contractor shall be required to minimize exposure of native glacial till to conditions that could render these soils unsuitable for reuse. The Contractor shall take the necessary precautions to maintain the native glacial till soils in a condition suitable for reuse, including the following:

1. Excavation shall not occur if significant precipitation is forecasted.
2. Soil intended for reuse shall not be excavated if soil has been exposed to a prolonged infiltrating rain.
3. When precipitation is forecasted, grade soil subgrades and compact the soil subgrades prior to the precipitation event to promote shedding of water off the subgrades and reduce the potential for infiltration, or use temporary covers (such as polyethylene) to shed precipitation off areas scheduled to be excavated that are sized suitable for temporary covers. To the extent possible, water should not be shed to areas to be excavated or filled.
4. Where "immediate" placement of soil intended for reuse is planned, the soil intended for reuse shall be placed and compacted as soon as possible once it is disturbed.

5. When reuse of excavated soil is not expected to be "immediate," stockpiling of the soil will be required, and the stockpiles shall be covered with anchored polyethylene sheeting/tarps or loam and seed (with the expectation that some of the upper soil may not be recoverable due to surficial water infiltration).
6. Stockpiles shall be graded relatively steeply to promote shedding of water.
7. Stockpile surfaces shall be tracked or otherwise compacted to minimize infiltration.

3.10 SOIL MOISTURE CONTROL

A. Soil found too wet for proper compaction shall be allowed to dry before rolling,. When necessary, moisture shall be added to soil by use of approved sprinkling equipment. Water shall be added uniformly and each layer shall be thoroughly disked or harrowed to provide proper mixing. Placing or rolling of material on earth fills will not be permitted during or immediately after rainfalls which increase the moisture content beyond the limit of satisfactory compaction. The earth fill shall be brought up uniformly and its top shall be kept graded and sloped so that a minimum of rainwater will be retained thereon. Compacted earth fill damaged by washing shall be acceptably replaced by the Contractor.

B. Uniformly aerate or moisten subgrade and each subsequent fill or backfill soil layer before compaction to within ±2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.11 TEMPORARY GROUNDWATER CONTROL

A. Dewatering will be required during construction where excavations extend below the groundwater table. Water infiltration to the foundation excavation should be able to be controlled using gravity-fed sump pumps via gravel trenches or sumps assisted with collector trenches. If these are not suitable, well-points may need to be installed for deeper excavations. The final dewatering measures required should be evaluated and designed by the contractor. The dewatering measures implemented should adequately dewater all foundation-related excavations such that compaction of footing subgrades is feasible.

B. Collection of rainwater runoff will also be needed during the subgrade preparation work. Water runoff is expected to be controlled with the use of gravel-lined collection trenches, pits and submersible pumps. Care should be taken to ensure that drainage is provided during all phases of excavation work. Environmental pretreatment of groundwater, if necessary, is beyond the scope of this study. Collected water should be discharged in accordance with applicable regulations.

3.12 SELECTION AND COMPACTION OF SOIL BACKFILLS AND FILLS

A. General: place acceptable soil structural and non-structural fill material in controlled, horizontal layers to required elevations.

B. Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Where on-site soils are reused, the Contractor must be prepared to devote the appropriate amount of effort to manage the moisture content of the material, install the material at a moisture content that is as close as possible to optimum, and completely compact each lift, even if thinner than normal lifts are necessary, to break up any clodof fine-grained material and prevent the burial of voids.

C. Compaction Criteria – All fill should be placed in uniform 12-inch-thick loose lifts and compacted. Fill in landscaped areas should be compacted to 90% of its maximum dry unit weight as determined by ASTM D1557. All other fill should be compacted to at least 95%. In restricted areas where only hand-operated compactors can be used, the maximum lift thickness should be limited to 8 inches. The appropriate water content at the time of compaction should be plus or minus 2% of optimum as determined by the laboratory compaction tests of proposed fill. No backfill should be placed on areas where free water is standing or on frozen subsoil areas.

D. Under footings, slabs, pavements, sidewalks, aprons and other structures, use Structural Fill or Crushed Stone as required. Use Structural Fill as backfill above utilities in areas that are load bearing. Where backfill is required below slabs, pavements, sidewalks, or aprons to reach subgrade elevations, approved Common Fill may be placed in accordance with Section 3.10.

E. Against wall structures, use only well-draining gravelly or coarse sandy soil as exterior backfill.

F. Backfill trenches with concrete where trench excavations pass under wall footings or within 18 inches laterally of column or wall footings and are lower in elevation than the bottom of such footings. Ensure trenching does not interfere with normal 45 degree bearing zone splay of any foundation. Place concrete up to level of bottom of adjacent footing. Special consideration may be required for pipes larger than 8 inches in diameter.

G. Approved tamping rollers shall be used for compacting all parts of the embankments that they can effectively reach. The Contractor shall demonstrate the effectiveness of the roller by actual soil compaction results of the soil to be used in the embankment with laboratory work performed by an approved soil testing laboratory

H. Place backfill and fill soil materials as indicated on the plans and as specified in CT DOT Form 818 for the type of material specified. Compaction shall be performed in accordance with the following:

Minimum compaction for fill and backfill, based on percentage of maximum dry density (as determined by ASTM D1557, Method C or AASHTO T-180 [Modified Proctor]), is:

Below Structures	-	95%
Behind Retaining Walls	-	95%
Exterior Wall Backfill (surface structures present)	-	95%
Exterior Wall Backfill		

(w/o surface structures)	-	90% (not greater than 92%)
Pavement Base/Subbase	-	95%
Below Pavement Subbase	-	95%
Embankments	-	93%
Slopes (not steeper than 3.5H:1V)	-	90%
Slopes (steeper than 3.5H:1V, ≤ 2.5H:1V)	-	92%
Areas of General Landscaping	-	90%

1. Fill materials must be placed in loose lifts not exceeding 10 inches in thickness for self-propelled vibratory rollers and 8 inches for vibratory plate compactors, and compacted to at least the maximum dry density presented in this subsection, depending upon fill placement location and intended purpose.
2. Common fill placed within 36 vertical inches below the Subbase Course subgrade for pavements should be compacted to 95 percent of the maximum dry density, and fill deeper than 36 inches shall be compacted to at least 93 percent of the maximum dry density.
3. Common fill placed within 12 vertical inches below the Subbase Course subgrade for exterior slabs and aprons should be compacted to 95 percent of the maximum dry density, and fill deeper than 12 inches should be compacted to at least 92 percent of the maximum dry density.
4. Common fill placed within 36 vertical inches below the subgrade for sidewalks should be compacted to 95 percent of the maximum dry density, and fill deeper than 36 inches should be compacted to at least 92 percent of the maximum dry density.
5. Common fill placed to construct built-up slopes (not steeper than 3.5H:1V) shall be compacted to 90 percent of the maximum dry density.
6. Common fill placed to construct built-up slopes (steeper than 3.5H:1V but not steeper than 2.5H:1V) shall be compacted to 92 percent of the maximum dry density.
7. Common fill shall not be placed to construct built-up slopes steeper than 2.5H:1V.
8. Common fill should not be used as a direct subgrade for concrete or asphalt sidewalks or pavement unless it meets base and/or subbase gradation requirements.
9. For common fill, the maximum particle size is recommended to be 8 inches, and no more than 35 percent by weight should pass the No. 200 sieve.

I. Under pavements, use Structural Fill as required, or approved Common Fill may be used in accordance with the following paragraphs upon approval from the Geotechnical Engineer or Architect:

1. If Common Fill is used to achieve pavement subgrades in total thickness of up to 48 inches and is compacted under ideal conditions, install at least 12 inches of compacted Structural Fill below the Subbase Course, increase the Subbase Course layer by at least 50 percent, or install a geosynthetic reinforcement layer (alternative selection to be determined by the Geotechnical Engineer or Architect).
2. If Common Fill is used to achieve pavement subgrades in total thickness greater than 48 inches and is compacted under ideal conditions, install at least 24 inches of compacted Structural Fill below the Subbase Course layer (if directed the Geotechnical Engineer or Architect).
3. If Common Fill is used to achieve pavement subgrade in total thickness greater than 24 inches and is compacted under less than ideal conditions, install at least 24 inches of compacted Structural Fill below the Subbase Course layer (if directed by the Geotechnical Engineer or Architect).

J. Where embankments are to be constructed, place and compact fill in accordance with the following paragraphs:
   1. No fill shall be placed until the foundation preparation and excavations in the foundation have been completed. No fill shall be placed on a frozen surface nor shall frozen material be incorporated.
   2. Embankment material shall be placed in horizontal layers. During construction, the surface of the fill shall have a crown or cross-slope of not less than two percent. Each layer or lift shall extend over the entire area of the fill.
   3. The fill shall be free from lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. The more pervious material shall be placed in the outside portion of the embankment or as indication on the drawings. The finished fill shall be shaped and graded to the lines and grade shown on the drawings.

K. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure. Uneven backfill outside foundation walls are permitted after slabs or suitable bracing are installed at the tops of the walls.

L. Backfill at outlet conduits shall be compacted by hand tamping with mechanical tampers. Heavy equipment shall not be operated within two feet of any structure. Equipment shall not be allowed to operate over the outlet conduits until there is 24 inches of fill over the pipe conduits.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding.

C. Finishing Embankments: Embankments shall be constructed to the elevations, lines, grades, and cross-sections as shown on the drawings. The embankments shall be maintained in a manner satisfactory to the engineer and surfaces shall be compact and accurately graded before topsoil is placed on them. The Contractor shall check the embankment slopes with stringlines to ensure that they conform to the slopes given on the plans and are uniform for the entire length of the slope.

3.14 SUBBASE AND BASE COURSES

A. Place subbase and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase and base course under pavements and walks as follows:

   1. Shape subbase and base course to required crown elevations and cross-slope grades.
   2. Compact subbase and base course as specified in CT DOT Form 818 Sections 2.12 and 3.04, respectively.

3.15 DRAINAGE COURSE

A. Place Crushed Stone (net cut areas) or Processed Aggregate Base Course (net fill areas) on subgrades free of mud, frost, snow, or ice.

1. On prepared subgrade, place and compact Crushed Stone (net cut areas) and drainage pipe under cast-in-place concrete slabs-on-grade as specified, followed by vapor retarder.
2. On prepared subgrade, place and compact Processed Aggregate Base Coarse (net fill areas) under cast-in-place concrete slabs-on-grade as specified, followed by vapor retarder.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified independent geotechnical engineer and/or testing agency to perform field quality control testing.

B. Allow Geotechnical Engineer and/or testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Footing and Slab Subgrade: Footing and slab subgrades shall be evaluated by the Geotechnical Engineer for suitability for foundation and slab bearing.

D. When Geotechnical Engineer and/or testing agency reports show that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; re-compact and retest until specified compaction is obtained.

3.17 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions at no additional compensation or change in Contract Time.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

B. Embankment Foundation Preparation

1. Areas where embankments are to be formed shall be cleared and grubbed of all topsoil and other organic materials to a depth of at least 24 inches. Unless otherwise specified on the drawings, foundation areas shall be scarified to a depth of three inches prior to placement of fill material.

C. Placement
   1. No fill shall be placed until the foundation preparation and excavations in the foundation have been completed. No fill shall be placed on a frozen surface nor shall frozen material be incorporated.
   2. Embankment material shall be placed in horizontal layers. During construction, the surface of the fill shall have a crown or cross-slope of not less than two percent. Each layer or lift shall extend over the entire area of the fill.
   3. The fill shall be free from lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. The more pervious material shall be placed in the outside portion of the embankment or as indication on the drawings. The finished fill shall be shaped and graded to the lines and grade shown on the drawings.

END OF SECTION 312000

SECTION 312319 – DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

B. Related Sections include the following:

1. Section 31 20 00 Earth Moving

1.02 SUBMITTALS

A. Shop Drawings: For dewatering system. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, discharge lines, frac tanks, piezometers, and flow-measuring devices; and means of discharge, control of sediment, and disposal of water.

B. Delegated-Design Submittal: For dewatering system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.03 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with all governing Federal, State, and Local regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Preinstallation Conference: Conduct conference at Project site.

1.05 PROJECT CONDITIONS

A. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements, 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 surveyed 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

3.01 INSTALLATION

A. Provide temporary grading to facilitate dewatering and control of surface water.

B. Monitor dewatering systems continuously.

C. Protect and maintain temporary erosion and sedimentation controls.

D. 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.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

E. 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.

F. 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.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

G. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.

H. 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 and at no change in Contract Time.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

END OF SECTION 312319

SECTION 312323 – EPS GEOFOAM FILL

PART 1 - GENERAL

1.1 SECTION INCLUDES

Expanded Polystyrene (EPS) Geofoam Fill and Soil Stabilization Material and accessories.

1.2 RELATED SECTIONS

Section 31 20 00 - Earth Moving.

Section 31 23 00 - Excavation and Fill.

SUMMARY

Section includes general requirements and procedures for compliance with certain prerequisites and credits needed for Project to obtain "LEED V 4 BD+C Silver certification.

Specific requirements for LEED are also included in other Sections.

Some LEED prerequisites and credits needed to obtain LEED certification depend on product selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.

A copy of the LEED Project checklist is attached at the end of this Section for information only.

Some LEED prerequisites and credits needed to obtain the indicated LEED certification depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.

1.3 REFERENCE STANDARDS

American Society for Testing and Materials – ASTM International (ASTM):

1. ASTM D6817/D6817M - Standard Specification for Rigid Cellular Polystyrene Geofoam.
2. ASTM D7180 - Standard Guide for Use of Expanded Polystyrene (EPS) Geofoam in Geotechnical Projects
3. ASTM C203 - Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
4. ASTM C303 - Standard Test Method for Dimensions and Density of Preformed Block and Board–Type Thermal Insulation.
5. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
6. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
7. ASTM D1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics.
8. ASTM D2863 - Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index).

9. ASTM D7557 - Standard Practice for Sampling of Expanded Polystyrene Geofoam Specimens.

1.4 SUBMITTALS

Submit under provisions of Section 01 30 00 – Administrative Requirements.

Product Data: Submit data on product characteristics, performance criteria, and product limitations.

Shop Drawings: Submit drawings with a profile and section view of proposed project, including individual layers of geofoam blocks in multiple-layer projects, indicating size, type, location, and orientation of geofoam blocks and related accessories.

Submit Manufacturer's Safety Data Sheet (SDS)

Test and Evaluation Reports: Submit independent third-party inspection agency's Evaluation Report(s) indicating compliance with ASTM D6817/D6817M and building codes for Geofoam.

Sustainable Design – Recycled Content and Regional Materials: Submit documentation of recycled content and manufacturing plant location relative to project location.

Qualification Data: Manufacturer's and Installer's Qualification Statements.

1.5 QUALITY ASSURANCE

Manufacturer Qualifications:

1. Company specializing in manufacturing products specified in this section, with not less than ten years documented experience.
2. Company maintains a current, third-party certified quality management system and environmental management system.

Installer Qualifications: Company specializing in performing work of the type and scope specified and with at least three years of documented experience.

Geofoam Block Qualifications:

3. Provide samples of Geofoam blocks upon initial project delivery in accordance with ASTM D7557 and test for compliance with Compressive Resistance minimum value at 1 percent deformation in accordance with ASTM D6817/D6817M requirements.
4. Mark Geofoam blocks to include individual block identifier, manufacturing date, and Type in compliance with ASTM D6817/D6817M.
5. Manufacturer shall maintain records of its quality assurance test results.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver materials with identification labels intact. The installer shall coordinate with the manufacturer's lead time requirements to prevent construction delays.

Provide temporary ballast or other restraint prior to and during installation. Geofoam is highly buoyant when submerged in water and adequate drainage and/or ballast shall be provided to resist potential uplift forces. Higher wind can also dislocate Geofoam blocks.

Comply with manufacturer's Safety Data Sheet (SDS), especially regarding:

1. Combustibility: Do not expose Geofoam to sparks, open flames, or any other sources of ignition nor to excessive heat of more than 75 degrees C (167 degrees F). Only store and use Geofoam in well-ventilated areas to prevent the build-up of flammable vapours. Prevent inhalation of any smoke, fumes, or dust from any burning or fabrication activities.

Incompatibility: Keep Geofoam protected from hydrocarbons (e.g. fuels, oils, tar, asphaltic mastic compounds), organic solvents (e.g. acetone/ketones, benzene, paint thinner, concrete curing compounds), ethers, esters, aldehydes and amines. Installer shall test Geofoam compatibility with mastics and other materials prior to use.

Ultra-Violet (UV) Light Exposure: Avoid prolonged exposure to UV light or direct sunlight that causes a layer of yellow dust to form on the surface of Geofoam. If required for adhesion or friction between blocks, remove the layer of yellow dust from the surface of any EPS Geofoam product as necessary, e.g. with broom or pressure washer.

Restrict equipment traffic that can impose contact pressures exceeding the allowable design stress of Geofoam. Protective materials such as sheathing or planks may be placed on the material to allow light rubber-tired equipment use.

Handling: Geofoam may be cut, drilled, sawn, rasped and otherwise handled similar to other construction materials, such as wood.

1.7 WARRANTY

Manufacturer shall provide a warranty that the products comply with their published specifications and are free from manufacturing defects.

PART 2 - PRODUCTS

1.8 MANUFACTURERS

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   A. Airfoam Industries Ltd., located at 19402 56 Avenue, Surrey, British Columbia V3S 6K4, Canada; Phone: 800.663.8162 or 1.604.534.8626; Website: www.airfoam.com.
   B. Insulfoam Manufacturing Facility, 2000 Summit View Drive, Smithfield, PA 15478, Phone: 855-207-0087, Fax: 855-246-9936

1.9 MATERIALS – EPS GEOFOAM

Provide Geofoam in locations and configurations as shown on the drawings, and to meet the following properties:

Type EPS15 per ASTM D6817:

1. Compressive resistance at 1% strain: **3.6 psi** minimum; ASTM D1621.
2. Flexural strength: 25 ps] minimum; ASTM C203.
3. Density: 0.9 lb/ft^3 minimum; ASTM D1622.
4. Buoyancy Force: 61.5 lbf/ft^3 maximum.

1.10 MATERIALS - ADDITIONAL PROPERTIES FOR ALL EPS GEOFOAM TYPES

Limiting Oxygen Index: minimum 24% per ASTM D2863. Geofoam shall contain a polymeric (non-HBCD) fire retardant modifier

Surface Burning Characteristics per ASTM E84 (UL 723):

1. Flame Spread Index ≤ 25.
2. Smoke-Developed Index ≤450 up to 6" thick.

Combustibility: Geofoam is combustible. GHS Classification: Non-Hazardous

Maximum service temperature:

3. Long-term exposure: 167°F.
4. Intermittent exposure: 176°F.

EPS Geofoam does not contain Formaldehyde, CFCs, HCFCs, nor HFCs

Poisson's ratio $\nu \approx 0.12$ within the elastic range (approximate).

Coefficient of friction: $\mu \approx 0.5\text{-}0.7$ along clean faces.

Coefficient of thermal expansion: $5 \cdot 10^{-5}$/K to $7 \cdot 10^{-5}$/K

Capillarity: none

Mold and Fungi: Geofoam does not promote mold and fungi growth per ASTM C1338.

Geofoam has no nutritional value for insects. To protect against insects/termites and water-vapor, place adequate physical barriers such as membranes around below-grade EPS. Where needed use adequate drainage to limit water absorption and buoyancy.

1.11 PERFORMANCE REQUIREMENTS

Exact dimensions of EPS Geofoam products to suit site conditions are determined by the installer in collaboration with the manufacturer and shall be approved by the engineer or architect of record.

EPS Geofoam standard blocks are 48" x 48" x 96"; full-size maxima are 48½" x 48½" x 194" within tolerances per ASTM D6817. Use of half blocks, smaller end pieces and thinner sheets may be used as needed to offset joints and complete the project per plans.

Geofoam blocks are factory-trimmed as necessary so surfaces are within tolerances of ASTM D6817; additional field cutting or trimming may be required and shall be completed on site by the installer with a saw or hot wire cutter.

Installer to correct damage to Geofoam as follows:

1. Slight Damage: Less than 0.12 ft^3 with no linear dimension greater than 1 ft [0.31 m] may be left in place.
2. Moderate Damage: Less than 0.35 ft^3 with no linear dimension greater than 3.3 ft^3 shall be filled with sand.
3. Geofoam blocks with excessive damage, such as exceeding the "Moderate Damage" category, shall be replaced with blocks that comply with dimensional requirements.
4. Geofoam blocks not in compliance with damage criteria may be cut to remove the excessive damage and the remaining undamaged portion of the block may be used within the fill, provided the undamaged portion of the block meets other requirements.

1.12 DESIGN CRITERIA

Select Geofoam for compressive resistance performance at 1 percent strain as required to resist live and dead load forces anticipated throughout the life of the structure.

Geofoam is thermal insulation that isolates the adjoining material from normal ground temperatures; consider freeze conditions and provide sufficient mass over Geofoam to avoid black ice conditions or other surface freeze events of supported structures.

Consider Geofoam's buoyancy forces and provide sufficient ballast on and/or drainage of Geofoam installations to prevent excessive uplift throughout the life of the structure.

Offset subsequent layers of Geofoam blocks 90 degrees in direction from previous layer, or stagger with sufficient overlaps, for increased fill-system stability.

For design and construction of highway embankments, refer to NCHRP Report 529 for additional information, http://www.trb.org/Publications/Blurbs/155003.aspx

For design of slope stability projects, refer to NCHRP Digest 380 for additional information, http://www.trb.org/Publications/Blurbs/168692.aspx

1.13 ACCESSORIES

Supply any materials, equipment, or other accessories required for the installation of Geofoam products.

Follow respective manufacturer's instructions for accessories and other items to be used in conjunction with Geofoam products.

PART 3 - EXECUTION

1.14 EXAMINATION

Examine and measure installation areas and subgrade conditions to receive Geofoam.

If subgrade or substrate preparation are not within specifications and the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

Submit all site measurements and project documentation pertaining to the Geofoam installation to the manufacturer for preparation of shop drawings. Notify the manufacturer of any changes in site conditions which may affect the layout or amount of Geofoam required.

Verify manufacturer's shop drawings and dimensions of all Geofoam and related products. Submit final shop drawings to the engineer of record for approval.

1.15 PREPARATION

Excavate and prepare installation site in accordance with design and project documentation as well as the shop drawings. Clear debris and dewater site as needed.

Grade according to elevations shown on plans; the finish grade shall be smooth and free from holes or protrusions to be adequately level for the Geofoam installation.

Cover graded area to receive Geofoam blocks with sand or other drainage layer as specified on drawings and level within tolerances per the engineer of record.

Ensure that the site has adequate access and space to receive and unload shipments of Geofoam products, safely store Geofoam products, maneuver EPS Geofoam products to the installation area, and perform any site fabrication activities if required.

1.16 INSTALLATION

Install Geofoam blocks according to drawings and tolerances approved by the engineer of record.

Provide necessary space to accommodate utilities, drainage and structural systems and their installation.

Cut and fit geofoam tightly around projections and penetrations. Complete additional fabrication for the installation of Geofoam products as required.

If specified, install accessories (membranes, connector plates, etc.), ballast and related components as required.

1.17 PROTECTION

Protect Geofoam blocks from: (1) Organic solvents such as acetone, benzene, and paint thinner; (2) Petroleum based solvents such as gasoline and diesel fuel; (3) Open flames.

Protect installed products and surface finishes from damage during construction.

Properly secure Geofoam blocks as needed to prevent dislocation from water, wind, backfilling or other site activities.

Remove and legally dispose of construction debris from project site. Return unused Geofoam material to the manufacturer for recycling, if it is clean, dry, and not mixed with any other materials.

END OF SECTION 312323

SECTION 320100 – MAINTENANCE AND PROTECTION OF TRAFFIC

PART 1 - GENERAL

1.01 MAINTENANCE AND PROTECTION OF TRAFFIC

A. Signage

1. All sign panels shall be the product of a professional sign painter or fabricator experienced in the production of signage meeting the requirements of the Manual of Uniform Traffic Control Devices. Panel size, colors, legend and letter type shall be strictly observed. Panel material shall be exterior plywood, aluminum sheet or extruded shapes, or other acceptable material. All items shall be completely weatherproof for the required length of the display.

2. Panel supports shall be wood or metal of substantial proportions and sufficiently braced to provide a reliable installation for the duration of the work. Supports shall be designed for 60-mph wind loads. Portable installations shall be ballasted to meet this requirement.

B. Channeling Devices

1. Traffic cones, pylons, vertical panels, barricades and other warning devices shall provide high visibility and be constructed of material which will impart minimum damage to errant vehicles or passengers. They shall contain bands of reflectorized material. Fifty-Five (55) gallon steel drums shall not be used.

C. Warning Lights

1. Warning lights shall be self-contained, weatherproof units and maintained to produce a sharp strobe beam, amber in color. Flash frequency shall be at least 20 per minute.

D. Installation

1. The type, number, deployment pattern, sequence of installation and dismantling, covering of permanent signs and all other details pertaining to various conditions evolving from construction operations as outlined in the Manual of Uniform Traffic Control Devices shall be strictly observed. Conditions not covered shall be resolved to the satisfaction of the regulatory agency having jurisdiction over the right of way.

E. Maintenance

1. The Contractor shall maintain all installed devices. Losses incurred as the result of accident, errant vehicles or pilferage shall be replaced in kind at the earliest date possible.

F. Dismantling

1. As soon as the work is complete and the site capable of receiving normal traffic operations, all temporary signs and control devices shall be removed and the original patterns restored. Modifications to permanent signage shall be removed.

G. Temporary Access

1. Contractor shall arrange his operations to provide continued access to properties and buildings and provide access to fire hydrants, manholes, gate boxes, or other utilities.

2. Whenever any trench will obstruct traffic in or to any public street, private driveway, or property entrance, the Contractor shall take such steps as required to maintain necessary traffic and access including temporary bridging if required. The Contractor shall provide a minimum of 24 hour notice to the owner of any temporary closures. If required, alternate access provisions shall be provided.

3. The Contractor shall confine his occupancy of public or traveled ways to the smallest space compatible with the efficient and safe performance of the work contemplated by the Contract.

H. Snow Removal

1. If the Contractor's operations interfere with the removal or sanding of snow or ice by the public authorities or adjoining landowners, in their customary manner, then the Contractor shall be required to perform such services for the public authorities or adjoining owners.

2. If the Contractor fails to do so, he shall reimburse the public authorities or adjoining landowners for doing such work. Together with any damage to the equipment of said parties, or claims of any parties for damage or injury or loss by reason of failure to remove snow or ice or to sand icy spots under these conditions.

I. Road Closure

1. In certain cases where deemed necessary for protection of the public, the Contractor with Town approval may close a road or driveway to vehicular traffic for a specified period of time. Prior to closing any roads, detours shall be established by the contractor and suitable signs erected. Access to all homes and businesses shall be maintained at all times for area residents and emergency vehicles. A request to close any road must be made in writing to the Town at least two days prior to the desired closure time.

1.02 TRAFFIC DIRECTORS

A. Traffic Directors

1. Traffic Directors provided by the Contractor are responsible for human safety and make the greatest number of public contacts of all construction personnel. It is important that qualified personnel be selected. A Traffic Director shall possess the following minimum qualifications:

a. Experience with traffic control
b. Good physical condition, including sight and hearing.

c. Mental alertness.
d. Courteous but firm manner.
e. Neat appearance.
f. Sense of responsibility for safety of public and crew.

2. The use of orange clothing such as a vest, shirt, or jacket shall be required for Traffic Directors. For nighttime conditions, similar outside garments shall be reflectorized.

3. Traffic Directors are provided at work sites to stop traffic intermittently as necessitated by work progress or to maintain continuous traffic past a work site at reduced speeds to help protect the work crew. For both of these functions, the Traffic Director must, at all times, be clearly visible to approaching traffic for a distance sufficient to permit proper response by the motorist to the flagging instructions, and to permit traffic to reduce speed before entering the work site. In positioning Traffic Directors, consideration must be given to maintaining color contrast between the Traffic Director's protective garments and his background.

B. Flags

1. Flags used for signaling purposes shall be a minimum of 24” by 24” in size, made of a good grade of red material securely fastened to a staff approximately 3’ in length. The free edge should be weighted to insure that the flag will hang vertically, even in heavy winds.

C. Paddles

1. Sign paddles should be at least 18” wide with letters at least 6” high. A rigid handle shall be provided. A 6’ handle (staff) is recommended. This combination sign may be fabricated from sheet metal or other light semi-rigid material. The background of the "STOP" face shall be red with white letters and border. The background of the "SLOW" shall be orange with black letters and border. When used at night the "STOP" face shall be reflectorized red with white reflectorized letters and border, and the "SLOW" face shall be reflectorized orange with black letters and border.

D. Flagging

1. The following methods of signaling with a flag shall be used:

a. **To Stop Traffic:** The Traffic Director shall face traffic and extend the flag horizontally across the traffic lane in a stationary position so that the full area of the flag is visible hanging below the staff. For greater emphasis, the free arm may be raised with the palm toward approaching traffic.

b. **When it is Safe for Traffic to Proceed:** The Traffic Director shall stand parallel to the traffic movement, and with flag and arm lowered from view of the driver, motion traffic ahead with his free arm. Flags shall <u>not</u> be used to signal traffic to proceed.

c. **Where it is Desired to Alert or Slow Traffic:** Where it is desired to alert or slow traffic by means of flagging, the Traffic Director shall face traffic and slowly wave the flag in a sweeping motion from the shoulder level to straight down without raising the arm above a horizontal position.

2. If a sign paddle is used, it shall be held in a stationary position with the arm extended horizontally away from the body. For added emphasis, the Traffic Director may slowly raise and lower his free hand with the palm down.

3. Lights, reflectorized sign paddles or reflectorized flags, shall be used to flag traffic at night. Daytime flagging procedures shall be followed whenever such lights, paddles or flags are used at night.

E. Traffic Directors Stations

1. Traffic Directors stations shall be located far enough in advance of the work site so that approaching traffic will have sufficient distance to reduce speed before entering the project. This distance is related to approach speed and physical conditions at the site, however, in no case will the distance be greater than 200 to 300’ between stations.

2. The Traffic Directors shall stand either on the shoulder adjacent to the traffic he is controlling or in the barricaded lane. At a "spot" obstruction he may have to stand on the shoulder opposite the barricaded section to operate effectively. Under no circumstances should he stand in the lane being used by moving traffic. He should be clearly visible to approaching traffic at all times. For this reason, he should stand alone, never permitting a group of workmen to congregate around him. He should be stationed sufficiently in advance of the work force to warn them of approaching danger, such as out-of-control vehicles.

3. Traffic Directors stations shall be adequately protected and preceded by proper advanced warning signs. At night, flagmen stations shall be adequately illuminated.

4. At short construction and maintenance lane closures where adequate sight distance is available for the safe handling of traffic, the use of one Traffic Director may be sufficient.

F. One-way Traffic Control

1. Where a one-way lane section is of any length, there shall be some means of coordinating movements at each end so that vehicles are not simultaneously moving in opposite directions in the section and so that delays are not excessive at either end.

2. Control points at each end of the route should be chosen so as to permit easy passing of opposing lines of vehicles.

3. Alternate one-way traffic control shall be accomplished by one of the following means:

   a. Traffic Director control, one at each end, using hand signals.
   b. Traffic Director control, using hand-held radios.

4. Where the one-lane section is short enough so that each end is visible from the other end, traffic may be controlled by means of a Traffic Director at each end of the section. One of the two should be designated as the Chief Traffic Director for purposes of coordinating movement. They should be able to communicate with each other verbally or by means of signals. These signals should not be such as to be mistaken for flagging signals.

5. Where the end of a one-lane section is not visible from the other end, the Traffic Director shall maintain contact by means of hand-held radios. So that a Traffic Director may know when to allow traffic to proceed into the section, description or license can identify the last vehicle from the opposite direction.

G. Coordination

1. If a Traffic Direction Service is used, the Contractor shall make all necessary arrangements and coordinate the need for traffic control before the service is required. The Contractor shall identify the number of personnel required and the time to report.

H. Use of Police

1. During certain times throughout the construction, and as determined by the Chief of Police, the Director, or the DOT, Police Officers may be required to be assigned to the construction site. These Officers will be assigned during period of heavy traffic or at intersection of major roads. The Police Officer will be in charge of traffic control at these sites. The Traffic Directors will augment the Police Officers. Coordination of the assignment of the Officers will occur between the Police Department and the Contractor. The Contractor is responsible for all costs associated with the use of Police Officers.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 320100

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. Section Includes:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt patching.

B. Related Requirements:

1. Section 311000 “Site Clearing” for demolition and removal of existing asphalt pavement.
2. Section 312000 "Earth Moving" for subgrade preparation, fill material, separation geotextiles, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
3. Section 321313 "Concrete Paving" for concrete pavement and for separate concrete curbs, gutters, and driveway aprons.
4. Section 321400 "Unit Paving" for bituminous setting bed for pavers and for stone and precast concrete curbs.

1.3 REFERENCE STANDARDS

A. CDOT Form 818: State of Connecticut Department of Transportation Standard Specifications for Roads, Bridges, Facilities and Incidental Construction Form 818; including latest Supplements.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.5 ACTION SUBMITTALS

A. Provide Quality Control plan for the preparation and installation of the asphalt paving.

B. Product Data: Include technical data and tested physical and performance properties.
   1. Herbicide.
   2. Paving geotextile.
   3. Joint sealant.

C. Hot-Mix Asphalt Designs:

   1. Certification, by authorities having jurisdiction, of approval of each hot-mix asphalt design proposed for the Work.
   2. For each hot-mix asphalt design proposed for the Work.

D. Sustainable Design Submittals:

E. Samples for Verification: For the following product, in manufacturer's standard sizes unless otherwise indicated:

   1. Paving Geotextile: 12 by 12 inches minimum.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For paving-mix manufacturer and testing agency.

B. Material Certificates: Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.

   1. Aggregates.
   2. Asphalt binder.
   3. Asphalt cement.
   4. Cutback prime coat.
   5. Emulsified asphalt prime coat.
   6. Tack coat.
   7. Fog seal.
   8. Undersealing asphalt.

C. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer qualified annually by the Connecticut Department of Transportation for the production of hot-mixed asphalt paving mixtures for use on Department projects.

B. Testing Agency Qualifications: Qualified in accordance with ASTM D3666 for testing indicated. The Contractor is responsible for Quality Control of the paving installation and shall provide quality control personnel throughout the paving operation.

C. Regulatory Requirements: Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the State of Connecticut Department of Transportation Standard Specifications for Roads, Bridges, Facilities and Incidental Construction Form 818, including current Supplements.
   1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

D. FIELD CONDITIONS
   1. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
      a. Prime Coat: Minimum surface temperature of 60 deg F.
      b. Tack Coat: Minimum surface temperature of 60 deg F.
      c. Slurry Coat: Comply with weather limitations in ASTM D3910.
      d. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
      e. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ConnDOT Form 817 Subarticle M.04.01-1.

C. Fine Aggregate: ConnDOT Form 817 Subarticle M.04.01-2.

D. Mineral Filler: ConnDOT Form 817 Subarticle M.04.01-3.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: ConnDOT Form 817 Subarticle M.04.01-4.

B. Emulsified Asphalts: ConnDOT Form 817 Subarticle M.04.01-5.

C. Water: Potable.

2.3 AUXILIARY MATERIALS

A. Reclaimed Asphalt Pavement (RAP) Recycle Option: ConnDOT Form 817 Subarticle M.04.01-6.

B. Joint Seal: Hot-poured rubber compound ConnDOT Form 817 Subarticle M.04.01-8.

C. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

2.4 MIXES

A. Hot-Mix Asphalt: dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:
   1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
   2. Superpave Mixes: ConnDOT Form 818 Subarticle M.04.02-2.
      a. Base/Binder Course: HMA S0.5.
      b. Surface Course: HMA S0.375.
      c. Sidewalk Mix: HMA S0.375.

2.5 FORMS

A. Wood or metal; straight, free from warp, and of sufficient strength to resist springing from the impact of the roller. Wood forms shall be 2-inch surfaced plank except that thinner material may be used at sharp curves. Forms shall be of a depth equal to the depth of the finished pavement section.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that aggregate base course is dry and in suitable condition to begin paving.

B. Adequately protect and leave in clean condition manhole frames and covers, catch basin grates, valve and meter boxes, curbs, walks, and walls.

C. Adjust manhole covers, catch basin grates, valve boxes and similar items to conform with pavement grade or as directed by the Engineer.

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

3.2 BITUMINOUS CONCRETE REPLACEMENT

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply 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.

C. Placing Patch Material: 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.

3.3 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Tack Coat: Apply uniformly to all contact surfaces, and to all pavement surfaces that have been in place longer than 5 calendar days, 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.

3.4 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in 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 a minimum temperature of 250 degrees 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.
6. Forms shall be used when hot mix asphalt is spread by hand. Forms shall be cleaned and oiled each time they are used. Forms shall be securely staked, braced, and held firmly to the required line and grade.

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. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
2. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
   1. Clean contact surfaces and apply tack coat to joints.
   2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
   3. Offset transverse joints, in successive courses, a minimum of 24 inches.
   4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
   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: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or 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.

3.7 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Base Course: Plus or minus 3/8 inch.
   2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement 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.

SCHEDULE 1 - FIELD QUALITY CONTROL

A. Contractor will provide quality control personnel throughout the paving process.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

D. Replace and compact hot-mix asphalt where core tests were taken.

E. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.2 WASTE HANDLING

A. General: Handle asphalt-paving waste in accordance with approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

END OF SECTION 321216

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SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

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 Concrete Paving Including the Following:

1. Concrete Walks and curb ramps.
2. Reinforced Concrete Walks.
3. Concrete Walks with Integral Curbing.
4. Tactile Warning Surfacing.
5. Concrete Paving Joint Sealants
6. Water repellant and chloride screen.

B. Related Requirements:
1. Section 017419 “Construction and Demolition Waste Management and Disposal.
2. Section 018113 “Sustainable Design Requirements”
3. Division 03 for general building applications of concrete.
4. Section 312000 “Earth Moving” for base and sub-base materials and compaction requirements.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to concrete paving, including but not limited to, the following:

a. Concrete mixture design.
b. Quality control of concrete materials and concrete paving construction practices.

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

a. Contractor's superintendent.
b. Concrete paving Subcontractor.

1.5 SUSTAINABLE DESIGN REQUIREMENTS

A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.

C. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.

D. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:

E. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified ready-mix concrete manufacturer.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Admixtures.
4. Curing compounds.
5. Applied finish materials.
6. Bonding agent or epoxy adhesive.
7. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

D. Field quality-control reports.

1.8 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Mockups: Build mockups to verify selections made under 1.6.D. above and to demonstrate aesthetic effects and set quality 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 where directed by Architect and not less than 96 inches (2400 mm) by 96 inches (2400 mm).
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. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) 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 design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in 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.

PART 2 - PRODUCTS

2.1 LEED PERFORMANCE REQUIREMENTS

A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2–PRODUCTS of Section 018113 – Sustainable Design Requirements

2.2 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.

2.3 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet (30.5 m) or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.4 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 60 percent.

B. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A, plain steel.

C. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M; with ASTM A615/A615M, Grade 60 (Grade 420) deformed bars.

D. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A; coated, deformed.

E. Epoxy-Coated, Joint Dowel Bars: ASTM A775/A775M; with ASTM A615/A615M, Grade 60 (Grade 420) plain-steel bars.

F. Tie Bars: ASTM A615/A615M, Grade 60 (Grade 420); deformed.

G. Hook Bolts: ASTM A307, Grade A (ASTM F568M, Property Class 4.6), internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

H. 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 of greater compressive strength than concrete specified, 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.

I. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

2.5 CONCRETE MATERIALS

A. Regional Materials: Concrete shall be manufactured within 100 miles (160 km) of Project site from aggregates and cementitious materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

B. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C150/C150M, gray portland cement Type I/II.
2. Fly Ash: ASTM C618, Class F.
3. Blended Hydraulic Cement: ASTM C595/C595M, Type IS, portland blast-furnace slag Type IP, portland-pozzolan cement.

C. Normal-Weight Aggregates: ASTM C33/C33M, Class 4S, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1-1/2 inches (38 mm) nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Air-Entraining Admixture: ASTM C260/C260M.

E. Chemical Admixtures: 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 C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.

5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

F. Water: Potable and complying with ASTM C94/C94M.

2.6 CURING MATERIALS

A. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

B. Water: Potable.

C. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.

2.7 RELATED MATERIALS

A. Joint Fillers: semi-rigid, closed-cell polypropylene foam, preformed joint filler that meets the following physical property requirements and fully complies with ASTM D8139.

1.	Compression Strength	30-60 psi	per ASTM D 545 or AASHTO T 42
2.	Compression Recovery	> 80%	per ASTM D 545 or AASHTO T 42
3.	Extrusion	< 0.1 in.	per ASTM D 545 or AASHTO T 42
4.	Density	>3.5 lbs./cu.ft.	per ASTM D 545 or AASHTO T 42
5.	Water Absorption	< 1.0%	per ASTM D 545 or AASHTO T 42
6.	Heat Resistance °F	392˚F± 5˚F	per ASTM D 5249
7.	Freeze Thaw Resistance	No change	per ASTM C 666 (300 cycles)
8.	UV Weathering	No change	per ASTM D 4329 (1000 hrs., Cycle A)
9.	Thickness	3/8 inch typical, 1/2 inch where walk abuts structures	

10. Provide cutting tool for pre-scoring the top edge of the joint filler, to allow removal of top portion for sealant application.

B. Joint Sealant for horizontal applications: Two component polyurethane elastomeric type complying with FS-TT-S-00227, self-leveling designed for foot traffic, 2c SL, as manufactured by SIKA, Pecora. Subject to compliance with requirements, provide the specified product or comparable product of BASF MasterSeal NP2 Sealant or LymTal International Iso-Flex 881 R Sealant.

1. Color to be selected by Landscape Architect.

C. Joint Sealant for vertical applications: Two component polyurethane elastomeric type complying with FS-TT-S-00230, non-sag, 2c NS EZ Mix, as manufactured by SIKA, Pecora. Subject to compliance with requirements, provide the specified product or comparable product of BASF MasterSeal NP2 Sealant or LymTal International Iso-Flex 881 R Sealant.

1. Color to be selected by Landscape Architect.

D. Sealant Backer Rod: Compressible rod stock or polyethylene foam, polyethylene jacketed, butyl rubber foam, or neoprene foam, as recommended by sealant manufacturer where required for back-up of sealant.

E. Grout: Non-shrink, non-staining grout.

F. Water repellant and chloride screen: Consolideck Saltguard WB, water based salt guard densifier, silane/siloxane water repellant and chloride screen as manufactured by Prosoco. Subject to compliance with requirements, provide the specified product or comparable product of Foundation Armor SX5000 WB or Ghostshield Siloxa-Tek 8500.

2.8 DETECTABLE WARNING SQUARE CAST IRON PAVER MATERIALS

A. Detectable Warning Square Cast Iron Paver Materials shall be a minimum of 60% post-consumer recycled content.

B. Detectable Warning Square Cast Iron Paver: 24 Inch x 24 inch paver.

1. Straight and radial detectable square cast iron paver warning plates shall be ADA II/ ABA compliant, with slip resistant surface.
2. Plate shall be heavy duty grey iron, compliant with ASTM A48 CL35B.
3. 24 inch width of tactile warning strip for dimensioned lengths, unless otherwise indicated on plans.
4. Provide radius sections as required to meet back of curb radii in project drawings.
5. Detectable Warning paver shall be manufactured with integral anchor lugs to ensure solid attachment to cast-in-place concrete.
    a. Cast iron paver shall be undipped Grey iron.
    b. Rust conditioner coating to be factory applied by the manufacturer.

2.9 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Pozzolan: 25 percent.
2. Slag Cement: 50 percent.

C. 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 1-1/2 percent for 1-inch (25-mm) nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Concrete Mixtures: Normal-weight concrete.

   1. Compressive Strength (28 Days): 4500 psi (31 MPa).
   2. Maximum W/C Ratio at Point of Placement: 0.45.
   3. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
   4. Solar Reflectance (SR): Three-year-aged SR value of at least 0.28 or initial SR of at least 0.33.

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M and ASTM C1116/C1116M. Furnish batch certificates for each batch discharged and used in the Work.
   1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

   1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph (5 km/h).
   2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
   3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch (13 mm) according to requirements in Section 312000 "Earth Moving."

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

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT INSTALLATION

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. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963/D3963M.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.

5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Expansion/Isolation Joints: Form expansion/isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 20 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Doweled Expansion Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat one-half of dowel length to prevent concrete bonding to one side of joint.
4. Pre-score the top edge of the joint filler with the manufacturer provided cutter tool. Install the joint filler system so that either the top edge of joint filler is at or slightly below the intended concrete surface.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. Remove top scored portion of joint filler after concrete has been placed and cured on both sides of joint.

D. Tooled/Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch (6-mm) radius. Repeat grooving of contraction joints after applying surface finishes.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) radius. Repeat tooling of edges after applying surface finishes.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 (ACI 301M) by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.

H. Screed paving surface 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 bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

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 design mixtures.

K. 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 in 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. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater 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. 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.

3.8 DETECTABLE WARNING SQUARE CAST IRON PAVER

A. Install detectable warning in accordance with manufacturer’s instructions at locations indicated on the drawings.

B. Any cutting required to fit detectable warning to an abutting piece, shall be done making every effort that cut line does not bisect the tactile domes, but falls between them. If cuts do bisect a dome, then the edge of the cut dome must be ground to meet ADA requirements for change in vertical grades. Cut pieces shall be dry fitted to ensure tight butt joint between plates prior to placing tactile warning in wet concrete.

C. Set pavers in wet concrete at final position. Keep wet concrete off of the top surface of the pavers at all times.

D. Press pavers into wet concrete to final elevation.

E. Finish concrete around assembled pavers.

F. Pavers must be flush with abutting concrete surface and flush curbing.

3.9 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 (1 kg/sq. m 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, curing compound or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

a. Water.

b. Continuous water-fog spray.
c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. 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.

3.10 SEALANT INSTALLATION

A. Install joint sealant in all expansion joints in accordance with manufacturer’s installation instructions. Remove dust, dirt and loose material. Clean and prime joints.

B. Apply sealants in continuous beads, without open joints, voids, or air pockets. Hand tool and finish all joints.

C. Confine materials to joint areas with masking tape or other precautions. Insure joint sealing is cleanly executed with no override onto adjacent pavement.

D. Remove excess compound promptly as work progresses and clean adjoining surfaces. Protect until fully cured.

E. In rough surfaces or joints of uneven widths, hold joint sealant well back into joints.

3.11 WATER REPELLANT AND CHLORIDE SCREEN

A. Apply water based water repellant and chloride screen per manufacturer’s instructions.

3.12 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 (ACI 117M) and as follows:

1. Elevation: 1/4 inch (6 mm).
2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
3. Surface: Gap below 10-feet- (3-m-) long; unleveled straightedge not to exceed 1/2 inch (13 mm).
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches (13 mm per 300 mm) of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch (25 mm).
6. Vertical Alignment of Dowels: 1/4 inch (6 mm).
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches (6 mm per 300 mm) of dowel.
8. Joint Spacing: 3 inches (75 mm).
9. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
10. Joint Width: Plus 1/8 inch (3 mm), no minus.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mixture 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 C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

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. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.14 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

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SECTION 321613 - CURBING

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 Precast Concrete Curbing, furnished in accordance with the dimensions and details of the plans, and installed to the lines and grades shown on the plans.

B. Related Requirements:

1. Section 321216 "Asphalt Paving" for bituminous curbing.
2. Section 321313 "Concrete Paving" for concrete walk with integral concrete curbing.

1.3 REFERENCE STANDARDS

A. Form 818 shall mean the State of Connecticut, Department of Transportation Standard specifications for Roads, Bridges and Incidental Construction, Form 818-January 2021 or its latest edition and any supplemental specifications.

1.4 PERMITS/APPROVALS

A. Obtain approval of construction and secure all permits for work in R.O.W. areas. Contractor shall be licensed to R.O.W. holder and pay all fees.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Precast concrete curbs including straight sections, inside radius and outside radius.

B. CT High Performance Building Submittals:

1. Recycled content materials.
2. Local materials.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store precast concrete curbing on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

1.8 FIELD CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.

3. When ambient temperature exceeds 100 deg F, or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F, set pavers within 1 minute of spreading setting-bed mortar.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of curb, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 CURBING

A. Precast Concrete Curbing: Conform to Form 818, Section 8.11. and the additional requirements below.

1. Class PCC04462 Concrete as defined in Form 818, M.03.02.
2. Exposure factor 2 – Severe: In contact with deicing chemicals.

B. Minimum length:

1. Straight curbing – 80% of the curbs shall be furnished in lengths of not less than 8 feet, and the remaining 20% in lengths of not less than 4 feet, interspersed at random, to allow for closures.
2. Radius curbing – curbs to be set on a radius of **100 feet or less** shall be cast to the curve required, and their ends shall be cast on radial lines. Requirements for length of individual curbs in curved curbing vary with radii of curves.
3. **Provide inside and outside radius curb where indicated on the drawings**.

C. Special pieces: provide slope transition curbs, 180-degree bullnose, 90-degree driveway corners, and other special pieces as indicated.

2.3 JOINT FILLER

A. Joint filler shall meet the requirements of Form 818, M.03.08-2.

2.4 BASE MATERIAL

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas indicated to receive curbing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance

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

3.2 PREPARATION

A. Ensure all utility conduit have been installed prior to backfill/subgrade preparation. Prepare subgrade by removing all soft or spongy material and backfilling with suitable material.

B. Conform to Article 1.8 Field Conditions above.

3.3 INSTALLATION

A. Do not use curbing with chips, cracks, voids, discolorations, or other defects that might be visible in finished work.

B. Curbing:

1. Install curbing to the lines, grades, and details shown in the drawings.

2. Subgrade

a. Compact the surface uniformly to 95% Modified AASHTO Laboratory density (ASTM D-1557, Method C).

1) Coordinate testing of subgrade and base with the Owner. Do not install base materials until schedule testing procedures are complete.

b. Base

c. Place maximum 6" layers.
   1) Compact each layer uniformly to 95% Modified AASHTO Laboratory density (ASTM D-1557, Method C).

d. Curb Installation

e. Set on edge. Settle into place with a heavy wooden hand rammer.
   1) Joints:

   2) Place concrete at the curb joints as shown on the drawings. Ensure that top exposed edge of curb face is consistent and true to line and grade. Support curb as required until concrete cures and all backfill operations have been completed.
      a) Point joints with mortar for the full depth and width of curbing. Conform to the details on the drawings.
      b) Omit concrete bed and mortar joint at 50 (+/-) foot intervals along curb installation to allow for expansion.

   3) Backfill with approved material.

3.4 REPAIRING AND CLEANING

A. Remove and replace curbing sections 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.

   a) Cleaning: Remove excess grout from exposed curbing surfaces; wash and scrub clean.

END OF SECTION 321613

SECTION 321723 – PAVEMENT MARKINGS

PART I - GENERAL

1.01 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.02 PAVEMENT MARKINGS

A. Materials

1. 15-minute dry paint: Conform to Article M.07.20 of Form 814A.

2. Fast drying paint: Conform to Article M.07.21 of Form 814A.

3. Glass beads: Conform to Article M.07.30 of Form 814A.

B. Preparation

1. Pavement areas to be painted shall be dry and cleaned of sand and road debris so as to provide an acceptable bond between the paint and the pavement.

C. Application

1. Paint shall be applied at a rate of 100 - 115 sf per gallon.

2. Glass beads shall be applied at a rate of 6 lbs. per gallon of paint for painted pavement markings and painted legend, arrows, and markings. For fast drying painted pavement markings, the rate shall be at 8 lbs. per gallon of paint.

3. Fast drying paint shall be applied at a temperature of 120 - 150 ^{0} F at the spray gun.

4. Painted centerline and shoulder lines shall be applied with a truck mounted sprayer.

5. All painting shall be performed in a neat and workmanlike manner. The lines shall be sharp and clear with no feathered edge or fogging and precautions shall be taken to prevent tracking by tires of the striping equipment. Paint shall be applied parallel to the road centerline or as shown on the plan with no unsightly deviations.

D. Protection

1. After application, the paint shall be protected from crossing vehicles for a time at least equivalent to the drying time of the paint.

E. Removal

1. Any existing painted markings that are shown to be removed or are directed to be removed shall be permanently removed from the pavement by any method that that does not damage the integrity of the pavement. Marring of the surface by sandblasting methods will be acceptable.

2. Sand or other material deposited on the pavement as a result of the removal process shall be removed as work progresses.

3. Painting existing markings black shall not be allowed.

F. Temporary markings

1. Commercially available temporary marking tape shall be installed on roads being used when the permanent pavement markings will not be applied immediately following removal or covering of existing markings or where temporary markings are needed.

2. The materials used and the installation shall be done in accordance with Article 12.12 of Form 814A.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 321723

SECTION 323124 - SOLID CELLULAR PVC FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Solid cellular PVC plastic lumber fence and gates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fences and gates.

1. Fence and gate posts, rails, and fittings.
2. Gates and hardware.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.

C. Samples for Verification: Prepared on Samples of size indicated below:

1. Submit samples for verification of PVC color in form of 3-inch lengths of actual product to be used in color selection

1.4 INFORMATIONAL SUBMITTALS

A. Installer Qualifications: Engage an experienced installer who has at least three years experience and has completed at least five Solid Cellular PVC fence and gate projects with same material and of similar scope to that indicated for this project with a successful construction record of in-service performance.

B. Product Certificates: For each type of fence, and gate, from manufacturer.

C. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer is to be qualified by having been in the business of making custom exterior cellular PVC structures for over 5 years.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

C. Allowable Tolerances:

1. Variation in component length: -0.00 / +1.00”
2. Variation in component width: ± 1/16”
3. Variation in component thickness: ± 1/16”
4. Variation in component edge cut: ± 2°
5. Variation in Density -0% + 10%

D. Workmanship, Finish, and Appearance:

1. Free foam cellular PVC that is homogeneous and free of voids, holes, cracks, and foreign inclusions and other defects. Edges must be square and top and bottom surfaces shall be flat with no convex or concave deviation.
2. Uniform surface free from cupping, warping, and twisting.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

B. Trim materials should be stored on a flat and level surface on a full shipping pallet. Handle materials to prevent damage to product edges and corners. Store materials under a protective covering to prevent jobsite dirt and residue from collecting on the boards.

1.7 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.

B. Verify locations of underground utilities and irrigation system.

1.8 WARRANTY

A. Provide manufacturer's standard limited warranty for products, stating that components will be free from defects in material that occur as a direct result of the manufacturing process, occur under normal use and service, occur during the warranty period and result in blistering, peeling, flaking, cracking, splitting, cupping, rotting or structural defects from termites or fungal decay.

1. Warranty Period: 25 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 COMPONENT ASSEMBLIES:

A. Basis-of-Design Product: Subject to compliance with requirements, provide reinforced cellular PVC fence and gate system assemblies and components fabricated by Walpole Woodworkers, 1079 Farmington Ave., Rt. 4, Farmington, CT 06032, Phone: 860-677-9690 or comparable product by Atlas Outdoor, 30 Northeast Industrial Road, Branford CT or Paragon Fence, LLC, PO Box 93, Southington CT.

2.2 PLASTIC LUMBER:

A. AZEK Trimboards manufactured by Azek Building Products, Inc., 894 Prairie Ave.; Wilmington, OH 45177; Toll Free Tel: 877-ASK-AZEK; Tel: 570-346-8797.

1. Material: Free foam cellular PVC material with small-cell microstructure.
2. Minimum performance and physical characteristic requirements:

    a. Density: 0.55 g/cm3 (ASTM D 792)
    b. Water Absorption: 0.15% (ASTM D 570)
    c. Tensile Strength: 2256 psi (ASTM D 638)
    d. Tensile Modulus: 144,000 psi (ASTM D 638)
    e. Flexural Strength: 3329 psi (ASTM D 790)
    f. Flexural Modulus psi 144,219 (ASTM D 790)
    g. Nail Hold: 35 Lbf/in of penetration (ASTM D 1761)
    h. Screw Hold: 680 Lbf/in of penetration (ASTM D 1761)
    i. Staple Hold: 180 Lbf/in of penetration (ASTM D 1761)
    j. Gardner Impact: 103 in-lbs (ASTM D 5420)
    k. Charpy Impact (@23°C): 4.5 ft-lbs (ASTM D 256)
    l. Coefficient of Linear Expansion: 3.2 x 10-5 in/in/°F (ASTM D 696)
    m. Burning Rate: No burn when flame removed (ASTM D 635)
    n. Flame Spread Index: 25 (ASTM E 84)
    o. Heat Deflection Temp 264 psi: 150 °F (ASTM D 648)
    p. Oil Canning (@140°F): Passed (ASTM D 648)

B. Structural Framework: Extruded seamless cellular PVC fabrications of sizes as shown on the Drawings. Reinforced with aluminum or steel shapes, and designed for minimal deflection under load.

C. Boards: Tongue and groove solid extruded seamless cellular PVC.

D. Finish: All materials to be spray painted and oven dried in custom color with two coats of with Sherwin-Williams vinyl safe paint and carrying a warranty of 25 years.

1. Color: As selected by Architect from manufacturer’s full range of standard and custom colors.

2.3 GATES

A. Double Gate: Gates shall be internally reinforced solid cellular PVC lumber to match adjacent solid board fence. Comply with 2.2 PLASTIC LUMBER above.

1. Gate Configuration: As indicated.
2. Gate Opening Width: As indicated.
3. Gate Height: As indicated.
4. Gate Color: Match adjacent solid board fence of same material. Comply with 2.2 PLASTIC LUMBER finish above.
5. Gate Frames: Fabricate gate frame from structural steel tubing welded to form rigid one-piece unit. Minimum size: 4" square, per manufacturer's shop drawings.
6. Bracing: Provide diagonal bracing on gates to prevent sag as required, per manufacturer's shop drawings.
7. Hardware materials: Hot dipped galvanized steel or malleable iron shapes to suit gate size. Field coat moveable parts with special coating provided by manufacturer, to match adjacent finishes.
8. Hinges: Heavy Duty hinges structurally capable of supporting gate leaf and allow opening and closing without binding. Non-lift-off type hinge design shall permit gate to swing 180.
9. Latch: Forked or slide bolt type capable of retaining gate in closed position and have provision for padlock. Latch shall permit operation from either side of gate.
10. Keeper: Provide keeper for each gate leaf. Gate keeper shall consist of mechanical device for securing free end of gate when in full open position.
11. Double Gates: Provide drop rods to hold each leaf. Provide gate stop pipes to engage center drop rods. Provide locking device and padlock eyes as an integral part of latch, requiring one padlock for locking both gate leaves.
12. Steel post: Schedule 40 galvanized standard-weight steel pipe complying with ASTM A 53/A 53M, or electric-resistance-welded pipe complying with ASTM A 135/A 135M.

    a. Pipe OD: Not less than 6-5/8 inches.
    b. Installation Method: Cast in concrete
    c. Steel Finish: Galvanized

2.4 ACCESSORIES

A. Fasteners: Provide fasteners recommended by the manufacturer, of size and type indicated, acceptable to authorities having jurisdiction, and that comply with requirements specified in this article for material and manufacture. Use stainless steel unless otherwise indicated.

B. Adhesives: Cellular PVC cement: AZEK Adhesive.

C. Sealants: Urethane, polyurethane, or acrylic based sealants without silicone.

2.5 CONCRETE

A. Concrete: CDOT Form 816, Article M.03.01, Class "C".

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify areas to receive fencing are completed to final grades and elevations.

B. Ensure property lines and legal boundaries are clearly established.

3.2 INSTALLATION

A. Drill post holes into firm undisturbed or compacted earth as detailed. Align each post for vertical and top alignment. Secure in position and fill with concrete up to within 3” of ground surface. Trowel finish around posts and slope to direct water away from posts.

B. Gate posts and corner posts on all fences and line posts on taller fences shall be filled with concrete for additional strength.

C. Set gate posts for gate opening specified in the construction drawings

D. Install fence in accordance with the manufacturer’s installation instructions, accurately to required lines and levels, true, plumb and level.

E. Check each post for vertical and top alignment, and maintain in position during placement and finishing operation.

F. Gate Installation;

1. Install gates plumb, level and secure using bolt-on hardware supplied by the manufacturer.
2. Adjust hardware for smooth operation.

3.3 CLEANING

A. Clean up during installation and upon completion of fencing work. Remove from site all waste and excess materials, debris, tools, and equipment. Repair any damage resulting from fence installation.

END OF SECTION 323124

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SECTION 323213 – SITE CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

SCHEDULE 1 - RELATED DOCUMENTS

PRODUCT DATA SHEET 1 - Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

SCHEDULE 2 - SUMMARY

PRODUCT DATA SHEET 1 - Work under this Section specifies site cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, embedded stair nosing, and finishes, for the following:

1.1 Equipment pads and bases.

1.2 Site retaining walls.

1.3 Site stairs and associated foundations.

SCHEDULE 3 - RELATED SECTIONS

PRODUCT DATA SHEET 1 - Related Sections include the following:

1.1 Section 31 20 00 Earth Moving

1.2 Section 03 30 00 Cast-in-Place Concrete

SCHEDULE 4 - SUBMITTALS

PRODUCT DATA SHEET 1 - General: Submit the following according to Conditions of the Contract and Division 01 Specification Sections.

PRODUCT DATA SHEET 2 - Product Data: For each type of product indicated.

PRODUCT DATA SHEET 3 - Design Mixtures: For each concrete mixture.

PRODUCT DATA SHEET 4 - Shop Drawings: For steel reinforcement and formwork.

PRODUCT DATA SHEET 5 - Material test reports and certificates for each of the following, signed by manufacturers:

1.1 Cementitious materials.

1.2 Admixtures.

1.3 Form materials and form-release agents.

1.4 Steel reinforcement and accessories.

1.5 Curing compounds.

1.6 Bonding agents.

1.7 Adhesives.

1.8 Semirigid joint filler.

1.9 Joint-filler strips.

1.10 Repair materials.

1.11 Anchoring adhesive.

PRODUCT DATA SHEET 6 - Detail of connection from drain spouts to drainage pipe.

SCHEDULE 5 - QUALITY ASSURANCE

PRODUCT DATA SHEET 1 - Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1.1 Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

PRODUCT DATA SHEET 2 - ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1.1 ACI 301, "Specification for Structural Concrete,"

1.2 ACI 117, "Specifications for Tolerances for Concrete Construction and Materials"

PRODUCT DATA SHEET 3 - Pre-installation Conference: Conduct conference at Project site.

PRODUCT DATA SHEET 4 - Testing and Inspection: Contractor shall employ and pay for a qualified independent laboratory to perform testing and inspection service required by these specifications and in compliance with the specifications outlined in the Form 818 - State of Connecticut Department of Transportation "Specifications for Roads, Bridges, Facilities and Incidental Construction" 2020 and latest supplements.

PRODUCT DATA SHEET 5 - Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

SCHEDULE 6 - Delivery, storage, and handling

PRODUCT DATA SHEET 1 - Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

PART 2 - PRODUCTS

SCHEDULE 1 - FORM-FACING MATERIALS

PRODUCT DATA SHEET 1 - Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

2.1 Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

A. High-density overlay, Class 1 or better.

PRODUCT DATA SHEET 2 - Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

PRODUCT DATA SHEET 3 - Chamfer Strips: New 45-degree wood, metal, PVC, plastic or rubber strips, 3/4 by 3/4 inch unless otherwise noted, nailed 6 inches on center, and installed in inside corners of forms.

PRODUCT DATA SHEET 4 - Form-Release Agent: Commercially formulated form-release agent with a maximum of 350 g/L volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.1 Formulate form-release agent with rust inhibitor for steel form-facing materials.

PRODUCT DATA SHEET 5 - Form Ties: Factory-fabricated, adjustable length, removable or snap-off metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

2.1 Furnish units that will leave no metal closer thank 1-1/2 inches to the plane of exposed concrete surface.

2.2 Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.

SCHEDULE 2 - STEEL REINFORCEMENT

PRODUCT DATA SHEET 1 - Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed.

2.1 Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M, epoxy coated, with less than 2 percent damaged coating in each 12-inch (300-mm) bar length.

PRODUCT DATA SHEET 2 - Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.

PRODUCT DATA SHEET 3 - Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

PRODUCT DATA SHEET 4 - Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, deformed steel.

PRODUCT DATA SHEET 5 - Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

2.1 For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless steel bar supports.

2.2 For Slabs-on-grade, use full 4”x3”x8” concrete blocks with a compressive strength equal to or greater than the adjacent cast-in-place concrete.

SCHEDULE 3 - CONCRETE MATERIALS

PRODUCT DATA SHEET 1 - Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

2.1 Portland Cement: ASTM C 150, Type II.

PRODUCT DATA SHEET 2 - Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.

2.1 Maximum Coarse-Aggregate Size: 3/4-inch (19-mm) nominal, unless otherwise noted.

2.2 Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

PRODUCT DATA SHEET 3 - Water: ASTM C 94/C 94M and potable.

PRODUCT DATA SHEET 4 - Air-Entraining Admixture: ASTM C 260.

PRODUCT DATA SHEET 5 - Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding 0.15

percent by mass of cement material. Do not use calcium chloride or admixtures containing calcium chloride.

2.1 Water-Reducing Admixture: ASTM C 494/C 494M, Type A.

2.2 Retarding Admixture: ASTM C 494/C 494M, Type B.

2.3 Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.

2.4 High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.

2.5 High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.

2.6 Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

SCHEDULE 4 - VAPOR RETARDERS

PRODUCT DATA SHEET 1 - Plastic Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.

PRODUCT DATA SHEET 2 - Plastic Vapor Retarder: ASTM E 1745, Class B. Include manufacturer's recommended adhesive or pressure-sensitive tape.

PRODUCT DATA SHEET 3 - Plastic Vapor Retarder: ASTM E 1745, Class C, or polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

SCHEDULE 5 - CURING MATERIALS

PRODUCT DATA SHEET 1 - Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

PRODUCT DATA SHEET 2 - Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

PRODUCT DATA SHEET 3 - Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

PRODUCT DATA SHEET 4 - Water: Potable.

PRODUCT DATA SHEET 5 - Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating. Moisture loss not more than 0.55 kg/sq. m when applied at 200 sq. ft./gal. Subject to compliance with current US EPA regulations for volatile organic compounds (VOC) emissions and floor finish adhesives.

PRODUCT DATA SHEET 6 - Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, non-dissipating [certified by curing compound manufacturer to not interfere with bonding of floor covering].

PRODUCT DATA SHEET 7 - Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

PRODUCT DATA SHEET 8 - Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

SCHEDULE 6 - RELATED MATERIALS

PRODUCT DATA SHEET 1 - Expansion- and Isolation-Joint-Filler Strips: [ASTM D 1751, 1/2 inch asphalt-saturated cellulosic fiber preformed into strips or ASTM D 1752, cork or self-expanding cork.

PRODUCT DATA SHEET 2 - Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

PRODUCT DATA SHEET 3 - Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

2.1 Type I and II, non-load bearing and Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

PRODUCT DATA SHEET 4 - Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

PRODUCT DATA SHEET 5 - Anchoring Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Epcon G5, Epcon A7 as manufacturing by ITW Ramset/Red Head or HIT RE-500-SD as manufactured by HILTI. Holes shall be drilled with a rotary hammer drill and carbide-tipped drill bit.

SCHEDULE 7 - CONCRETE MIXTURES

PRODUCT DATA SHEET 1 - Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

PRODUCT DATA SHEET 2 - Design concrete mixes for slabs-on-grade and housekeeping pads to provide concrete with the following properties:

2.1 Normal weight concrete with a 4,000 psi, 28-day minimum compressive strength, minimum cement content of 6 sacks per cubic yard, water-cement ratio 0.45 maximum

(water content shall include surface water in aggregates), maximum 3/4-inch aggregate, four plus or minus 1 inch slump. Provide six percent air content by volume at all exterior slabs.

PRODUCT DATA SHEET 3 - Design concrete mixes for all normal-weight concrete mixtures not indicated above with the following properties:

2.1 Minimum Compressive Strength: 4000 psi or 3000 psi at 28 days as specified on the Contract Drawings.

2.2 Maximum Water-Cementitious Materials Ratio: 0.50, watertight concrete 0.45.

2.3 Slump Limit: 4 inches (100 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture , plus or minus 1 inch (25 mm).

2.4 Air Content: 5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.

2.5 Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) or 3/4-inch (19-mm)] nominal maximum aggregate size.

2.6 Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.

SCHEDULE 8 - FABRICATING REINFORCEMENT

PRODUCT DATA SHEET 1 - Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

SCHEDULE 9 - CONCRETE MIXING

PRODUCT DATA SHEET 1 - Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, and furnish batch ticket information.

2.1 When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

SCHEDULE 10 - STAIR NOSING SYSTEM

PRODUCT DATA SHEET 1 - Model DST-330 two-component stair nosing as manufactured by Balco, Inc., P.O. Box 17249, 2626 S. Sheridan, Wichita, KS 67217. Tel: (800) 767-0082 or (316) 945-9328. Fax: (316) 945-0789.

2.1 Extruded aluminum sub-channels and tread plates shall be ASTM B221 alloy 6063-T5. Mill finish, heat-treated. Components to be embedded in concrete shall be clear acrylic lacquer coated. Clear anodized finish.

2.2 Abrasive ribs shall be two-part epoxy combined with aluminum oxide grit. Color: black.

2.3 Fasteners: Standard and Tread plate securing screws.

PART 3 - EXECUTION

SCHEDULE 1 - General

PRODUCT DATA SHEET 1 - Coordinate the installation of joint materials, vapor retarder, embedded items, anchor bolts and other related materials with placement of forms and reinforcing steel.

PRODUCT DATA SHEET 2 - Thoroughly clean forms, metal deck and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, welding ferrules and/or other debris just before placing concrete.

SCHEDULE 2 - FORMWORK

PRODUCT DATA SHEET 1 - Design, erect, shore, brace, and maintain formwork according to ACI 301 to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

PRODUCT DATA SHEET 2 - Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

PRODUCT DATA SHEET 3 - Construct forms tight enough to prevent loss of concrete mortar.

PRODUCT DATA SHEET 4 - Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

3.1 Install keyways, reglets, recesses, and the like, for easy removal.

3.2 Do not use rust-stained steel form-facing material.

PRODUCT DATA SHEET 5 - Chamfer exterior corners and edges of permanently exposed concrete and where indicated on Contract Drawings to produce uniform smooth lines and tight edge joints.

PRODUCT DATA SHEET 6 - Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

PRODUCT DATA SHEET 7 - Coat contact surfaces of forms with form-release agent, according to manufacturer’s written instructions, before placing reinforcement.

PRODUCT DATA SHEET 8 - Do not allow excess form-coating material to accumulate in forms or come into contact with in-place concrete surfaces against which fresh concrete will be placed.

SCHEDULE 3 - EMBEDDED ITEMS

PRODUCT DATA SHEET 1 - Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded. Provide and install a protective coating between all concrete and aluminum materials.

SCHEDULE 4 - STEEL REINFORCEMENT

PRODUCT DATA SHEET 1 - General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

3.1 Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

SCHEDULE 5 - CONCRETE PLACEMENT

PRODUCT DATA SHEET 1 - Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed. Notify other trades to permit installation of their work.

PRODUCT DATA SHEET 2 - Do not add water to concrete during delivery, at Project site, or during placement.

PRODUCT DATA SHEET 3 - Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

3.1 Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

PRODUCT DATA SHEET 4 - Cold-Weather Placement: Comply with ACI 306.1 and as indicated:

3.1 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.

3.2 Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

3.3 Do not use calcium chloride, salt, or other materials containing antifreeze agent or chemical.

3.4 Slabs-on-Grade (Slab depth Less than 10 Inches):

A. Concrete operations for slabs indicated above are to take place within a heated enclosure where the air temperature is maintained between 50 deg F and 85 deg F for a minimum of 24 hours prior to concrete placement and 72 hours after concrete placement. Ground surface is to be free of frost or frozen materials for slabs-on-grade.

PRODUCT DATA SHEET 5 - Hot-Weather Placement: Comply with ACI 301.

SCHEDULE 6 - FINISHING FORMED SURFACES

PRODUCT DATA SHEET 1 - Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

3.1 Apply to concrete surfaces not exposed to public view.

PRODUCT DATA SHEET 2 - Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove and smooth fins and other projections completely.

3.1 Apply to concrete surfaces exposed to view, or to be covered with a coating or covering material applied directly to concrete.

PRODUCT DATA SHEET 3 - Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

SCHEDULE 7 - Miscellaneous concrete items

PRODUCT DATA SHEET 1 - Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

SCHEDULE 8 - CONCRETE PROTECTING AND CURING

PRODUCT DATA SHEET 1 - General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

PRODUCT DATA SHEET 2 - Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m 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.

PRODUCT DATA SHEET 3 - Cure concrete according to ACI 308.1, by one or a combination of the following methods:

3.1 Moisture Curing: Keep surfaces continuously moist for not less than seven days.

3.2 Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3.3 Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

A. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer. Curing and sealing compound in subparagraph below is usually for floors and slabs and may act as a permanent surface finish.

3.4 Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a 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. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

SCHEDULE 9 - STAIR NOSING SYSTEM

PRODUCT DATA SHEET 1 - Install stair nosings in accordance with the manufacturer’s written installation instructions. Sub-channels of two-component stair nosings shall be installed during the concrete pour. Anchors shall be embedded and 3 inches from each end and 12 inches on center. Abrasive tread plates shall be installed in the final stage of construction. Work shall be aligned plumb, level, and flush with adjacent surfaces and rigidly anchored to the substrate.

PRODUCT DATA SHEET 2 - Clean exposed surfaces as recommended by the manufacturer. Protect the finished work from damage by work of other Sections during the remainder of the construction period.

SCHEDULE 10 - FIELD QUALITY CONTROL

PRODUCT DATA SHEET 1 - Testing and Inspecting: Contractor shall employ and pay for a qualified independent laboratory and inspecting agency to perform testing and inspection services and prepare test reports required by these specifications.

3.1 Testing Services: Tests shall be performed according to ACI 301.

3.2 Concrete testing shall be performed at a minimum testing frequency of one slump, air, and temperature test per day or per 50 cubic yards of concrete placed, whichever is greater.

3.3 Compressive cylinder specimens shall be prepared at the frequency of one set of cylinders per day or per 50 cubic yards of concrete placed, whichever is greater. A minimum of one 7-day cylinder and two 28-day cylinders shall be prepared per cylinder set for acceptance.

END OF SECTION 323213

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. Seating – Stone Slab.
   2. Bollards – metal pipe with covers.
   3. Timber guide rails

B. Related Requirements:

   1. Section 033000 "Cast-in-Place Concrete" for concrete footings.
   2. Section 312000 "Earth Moving" for excavation for installing concrete footings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Samples: For each exposed product and for each color and texture specified.

D. Samples for Initial Selection: For units with factory-applied finishes.

E. Samples for Verification: For each type of exposed finish, not less than 6-inch-long linear components and 4-inch-square sheet components.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For site furnishings manufactured with preservative-treated wood.

   1. Indicate type of preservative used and net amount of preservative retained. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For site furnishings to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 SEATING – STONE SLAB

A. Granite: ASTM C 615.
   1. Stone shall come from a single quarry, with sufficient reserves to satisfy the requirements of the project. The granite supplier shall have the capabilities to cut and finish the stone without delaying the project.
   2. Stone Source Examination: Make quarried blocks available for examination by the Landscape Architect.
   3. Color and Grain: Light gray/white with fine to medium grain.
   4. Finish: As indicated on Drawings.
   5. Size: As indicated on Drawings. Cut stone from one block.

B. Dowels: Stainless steel, size as indicated on Drawings.

C. Mortar Setting Bed: Conform to CDOT Form 817-2018, Article M.11.04.

D. Concrete: Conform to CDOT Form 817-2018, Article M.03.02, Class "C".

2.2 BOLLARDS

A. Bollard Construction:
   1. Pipe OD: Not less than as indicated on the drawings.
   2. Steel: Schedule 80 extra strong pipe.
   3. Overall Height: As indicated.
   4. Overall Width: As indicated.
   5. Overall Depth: As indicated.

B. Steel Finish: Galvanized.

C. Bollard Cover:
   1. Basis-of-Design Product: Subject to compliance with the requirements, provide product indicated on the Drawings, 1/4-Inch Dome-Top Plastic Bollard Cover manufactured by Ideal Shield, 2525 Clark Street, Detroit MI 48209-1355. Tel: 877-325-0769.or as manufactured by Post Guard or ULINE.
      a. Dome top low-density polyethylene thermoplastic tubes having ultra-violet resistance and anti-static properties
      b. Nominal thickness of 0.250 inch.
      c. Sleeves to shield nominal pipe diameters: 5-inches and 8-inches.
      d. Sleeve height: as detailed.
      e. Sleeve color: as selected by the Architect from standard pantone colors.
      f. Surface of sleeve to be smooth with round top; no ribbed or two-piece systems will be accepted.
   2. Secure with manufacturer's neoprene adhesive tape; no screws, glue, or clamping will be accepted.

D. MATERIALS
   1. Steel and Iron: Free of surface blemishes and complying with the following:

a. Steel Pipe: Extra strong weight steel pipe complying with ASTM A53/A53M, or electric-resistance-welded pipe complying with ASTM A135/A135M.

2. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M; recommended in writing by manufacturer, for exterior applications.
3. Galvanizing: Where indicated for steel and iron components, provide the following protective zinc coating applied to components after fabrication:
   a. Hot-Dip Galvanizing: According to ASTM A123/A123M, ASTM A153/A153M, or ASTM A924/A924M.
4. Concrete for infill of bollards: Connecticut Department of Transportation Standard Specifications Form 817, Article M.03.01, Class ‘C’.

2.3 TIMBER GUIDE RAIL

A. LUMBER, GENERAL

1. Comply with DOC PS 20 and with grading rules of lumber grading agencies certified by ALSC's Board of Review as applicable. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by ALSC's Board of Review.
   a. Factory mark each item with grade stamp of grading agency.
   b. For items that are exposed to view in the completed Work, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
   c. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
   d. Provide dressed lumber, S4S, unless otherwise indicated.
2. Maximum Moisture Content:
   a. Boards: 19 percent.
   b. Timber. 19 percent.

B. LUMBER

1. Dimension Lumber: No. 2 grade and the following species:
   a. Mixed southern pine; SPIB.

C. POSTS

1. Timber Posts: Southern pine; No. 2; SPIB.

D. PRESERVATIVE TREATMENT

1. Pressure treat boards and dimension lumber with waterborne preservative according to AWPA U1; Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
2. Pressure treat timber with waterborne preservative according to AWPA U1; Use Category UC4a.
3. Preservative Chemicals: Acceptable to authorities having jurisdiction.
   a. Do not use chemicals containing arsenic or chromium.
4. Use process that includes water-repellent treatment.
5. After treatment, re-dry to 19 percent maximum moisture content.
6. Mark treated wood with treatment quality mark of an inspection agency approved by ALSC's Board of Review.

7. For items indicated to receive a stained or natural finish, mark each piece on surface that will not be exposed or omit marking and provide certificates of treatment compliance issued by inspection agency.

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 SEATING 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 at locations indicated on Drawings.

3.3 BOLLARD INSTALLATION

A. Install bollards, plumb, true, and securely anchored in concrete at locations indicated on Drawings.

B. Fill bollards with concrete and clean outside surfaces.

C. Install bollard covers per manufacturers recommendations.

3.4 TIMBER GUIDE RAIL INSTALLATION

A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit work to other construction; scribe and cope as needed for accurate fit.
   1. Tolerances: Guiderail shall not deviate more than 1/2-inch in line to finished grade between each post section.

B. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of members or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

C. Drill post holes into firm undisturbed or thoroughly compact soil. The bottoms of dug holes shall be thoroughly rammed to provide a stable foundation. Install and tamp crushed stone base. Backfill dug holes with approved material tamped in 4-inch layers in such a way as not to shift the posts from the correct alignment.

D. Align each post both vertically and laterally on crushed stone base. Secure in position during backfilling operations. Posts shall be set at a constant vertical alignment above finished grade. Posts shall be set at a constant distance from edges of pavements.

E. Smoothly finish grade around posts to prepare for replacement conditions. Provide topsoil for all proposed lawn areas. Pitch ground surface away from posts and do not allow water to stand adjacent to post bases.

3.5 CLEANING AND PROTECTION

A. Protect furnishings from damage.

B. Immediately prior to Substantial Completion, clean furnishings in accordance with manufacturer’s instructions to remove dust, dirt, adhesives, and other foreign materials.

C. Touch up damaged finishes according to manufacturer’s instructions.

END OF SECTION 323300

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SECTION 329115 - SOIL PREPARATION (PERFORMANCE SPECIFICATION)

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 planting soils specified according to performance requirements of the mixes.

B. Related Requirements:
   1. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
   2. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
   3. Section 329300 "Plants" for placing planting soil for plantings.

1.3 DEFINITIONS

A. AAPFCO: Association of American Plant Food Control Officials.

B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

C. CEC: Cation exchange capacity.

D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

F. Imported Soil: Soil that is transported to Project site for use.

G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.

H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.

J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.

M. SSSA: Soil Science Society of America.

N. 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.

O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

Q. USCC: U.S. Composting Council.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for application and use.
2. Include test data substantiating that products comply with requirements.
3. Include sieve analyses for aggregate materials.
4. Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:

    a. Manufacturer's qualified testing agency's certified analysis of standard products.
    b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
    c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

B. Sustainable Design Submittals:

C. Samples: For each bulk-supplied material, 1-gal. volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For each testing agency.

B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

C. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil and imported soil.

1. Notify Architect seven days in advance of the dates and times when laboratory samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.9 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. Sample Collection and Labeling: Have samples taken and labeled by [Owner] [Contractor in presence of Architect] [soil scientist (CPSS) certified by SSSA] [soil classifier (CPSC) certified by SSSA] [soil scientist (RPSS) registered by the National Society of Consulting Soil Scientists] [or] [state-certified, -licensed, or -registered soil scientist] <Insert requirement> under the direction of the testing agency.

1. Number and Location of Samples: Minimum of three representative soil samples from varied locations for each soil to be used or amended for landscaping purposes.
2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.10 TESTING REQUIREMENTS

A. General: Perform tests on soil samples according to requirements in this article.

B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":

a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
b. Hydrometer Method: Report percentages of sand, silt, and clay.

C. Chemical Testing:

1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.
4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.

D. Fertility Testing: Soil fertility analysis according to standard laboratory protocol of SSSA NAPT NEC-67, including the following:

1. Percentage of organic matter.
2. CEC, calcium percent of CEC, and magnesium percent of CEC.
3. Soil reaction (acidity/alkalinity pH value).
4. Buffered acidity or alkalinity.
5. Nitrogen ppm.
6. Phosphorous ppm.
7. Potassium ppm.
8. Manganese ppm.
9. Copper ppm.
10. Sodium ppm and sodium absorption ratio.
11. Soluble-salts ppm.
12. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
13. Other deleterious materials, including their characteristics and content of each.

E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3-Chemical Methods."

F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inchdepth of soil.
2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inchdepth of soil.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.

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. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED ACCORDING TO PERFORMANCE REQUIREMENTS

A. Planting-Soil Type 1: Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce viable planting soil. Using preconstruction soil analyses and materials specified in other articles of this Section, amend existing, on-site surface soil to become planting soil complying with the following requirements:

1. Particle Size Distribution by USDA Textures: Classified as sandy loam or loam soil according to USDA textures.

2. Percentage of Organic Matter: Minimum 5 to 8 percent by volume.
3. Soil Reaction: pH of 6 to 7.
4. Fertility: N,P, K, Mg, and Ca in amounts recommended by the testing laboratory for the turf types and plant groups to be installed.
5. RCRA Metals: Below maximum limits established by the CT DEEP.
6. Phytotoxicity: Below phytotoxicity limits established by SSSA.

B. Planting-Soil Type 2: Imported, naturally formed soil from off-site sources and consisting of sandy loam or loam soil according to USDA textures; and modified to produce viable planting soil. Amend imported soil with materials specified in other articles of this Section to become planting soil complying with the following requirements:

1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from agricultural land, bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.
2. Additional Properties of Imported Soil before Amending: Minimum of 4 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration. Clean soil to be of the following:

    a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
    b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.
    c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 1 ½" in any dimension.

3. Percentage of Organic Matter: Minimum 5 to 8 percent by volume.
4. Soil Reaction: pH of 6 to 7.
5. Fertility: N, P, K, Mg, and Ca in amounts recommended by the testing laboratory for the turf types and plant groups to be installed.
6. RCRA Metals: Below maximum limits established by the CT DEEP.
7. Phytotoxicity: Below phytotoxicity limits established by SSSA.

C. Planting-Soil Type 3 – Rain Garden Mix: Manufactured soil blended to produce viable planting soil.

1. Mix Proportions:
    a. 20-25% Planting soil Type 1 or Type 2 listed above.
    b. 20-25% Double shredded bark mulch – conforming to paragraph A of Article 2.3, Section 329300.
    c. 50-60% Sand conforming to paragraph D of Article 2.2 below.
2. Amended Mix Soil Reaction: pH of 5.2 to 7.0.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
2. Form: Provide lime in form of ground dolomitic limestone.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C33/C33M.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:

1. Feedstock: Limited to leaves.
2. Reaction: pH of 5.5 to 8.
3. Soluble-Salt Concentration: Less than 4 dS/m.
4. Moisture Content: 35 to 55 percent by weight.
5. Organic-Matter Content: 40 to 60 percent of dry weight.
6. Particle Size: Minimum of 98 percent passing through a 1-inch sieve.

2.4 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

PART 3 - EXECUTION

3.1 GENERAL

A. Place planting soil and fertilizers according to requirements in other Specification Sections.

B. 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 planting soil.

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

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches and stockpile until amended.

B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

C. Unsuitable Materials: Clean soil to contain a combined maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

D. Screening: Pass unamended soil through a 2-inch sieve to remove large materials.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 4 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.

C. Mixing: Spread unamended soil to total depth of 6 inches, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.

    a. Mix lime and sulfur with dry soil before mixing fertilizer.
    b. Mix fertilizer with planting soil no more than seven days before planting.

D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698 except rain garden/detention basin bottom mix.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 PLACING AND COMPACTION OF RAIN GARDEN (TYPE III) PLANTING SOIL

A. Scarify the rain garden subgrade prior to filter media (planting soil) placement.

B. The rain garden planting soil shall be placed and graded using low ground-contact pressure equipment or by excavators and/or backhoes operating on the ground adjacent to the rain garden.

C. No heavy equipment shall be used within the perimeter of the bioretention facility before, during, or after the placement of the rain garden planting soil.

D. The rain garden planting soil shall be placed in horizontal layers not to exceed 12 inches for the entire area of the rain garden.

E. Saturate the entire area of the rain garden after each lift of soil is placed until water flows from the underdrain. Water for saturation shall be applied by spraying or sprinkling. Saturation of each lift shall be performed in the presence of the Drainage Engineer. An appropriate sediment control device shall be used to treat any sediment-laden water discharged from the underdrain.

F. Final grading of the rain garden planting soil shall be performed after a 24-hour settling period.

G. If the rain garden planting soil becomes contaminated during the construction of the basin, the contaminated material shall be removed and replaced with uncontaminated material.

H. Do not use pesticides, herbicides or fertilizers in the rain garden planting soils.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:
   1. Performance Testing: For each amended planting-soil type, demonstrating compliance with specified performance requirements. Perform testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

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

D. Prepare test and inspection reports.

E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.6 PROTECTION

A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."

B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Vehicle traffic.
4. Foot traffic.
5. Erection of sheds or structures.
6. Impoundment of water.
7. Excavation or other digging unless otherwise indicated.

C. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.7 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 329115

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.

1.2 SUMMARY

A. Section Includes:

1. Seeding.
2. Hydroseeding.
3. Lawn turf, New England Wetmix for basins and New England Conservation/Wildlife mix.

B. Related Requirements:

1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329115 "Soil Preparation (Performance Specification)" and drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product data for each type of product.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. 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.

1. Certification of each seed mixture for turfgrass seed. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf and meadows during a calendar year. Submit before expiration of required maintenance periods.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn turf, New England Wetmix and New England Conservation/Wildlife mix establishment.

1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
2. Experience: Five years' experience in turf installation in addition to requirements in Section 014000 "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 National Association of Landscape Professionals:

a. Landscape Industry Certified Technician - Exterior.
b. Landscape Industry Certified Lawn Care Manager.
c. Landscape Industry Certified Lawn Care Technician.

5. Pesticide Applicator: State licensed, commercial.

1.9 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 compliance with state and Federal laws, as applicable.

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 materials with appropriate certificates.

C. Planting soil shall not be delivered or worked in a frozen or muddy condition.

1.10 FIELD CONDITIONS

A. Provide protection and security as necessary to prevent damage to athletic field and lawn areas by any cause, including vandalism and unauthorized usage, prior to acceptance of seeded areas by the Owner.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting acceptance.
1. Lawn turf:
   a. Spring Planting: April 1 to June 15.
   b. Fall Planting: August 15 to October 1.
2. New England Wetmix:
   a. Fall planting August 15 to October 1.
   b. Spring planting: March 15 to **May 15**.
3. New England Conservation/Wildlife mix:
   a. Fall planting August 15 to October 1.
   b. Spring planting: March 15 to **May 15**.

C. 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.

D. Watering: The Contractor shall bear sole responsibility for the furnishing and application of all irrigation water, irrespective of whether or not an irrigation system is installed or operable. The Contractor shall ensure that all irrigation water is applied at the proper frequency, coverage and in the proper amounts to fulfill the plant establishment and maintenance requirements of the Contract. The Contractor’s responsibility for all watering shall begin upon delivery of plants to the site, and shall continue through the end of the Warranty period.

1. If no irrigation system is available, or if an available irrigation system is unsatisfactory to the Contractor's needs, then the Contractor shall furnish and apply all irrigation water.
2. If an existing irrigation system is made available for the Contractor's use, and if the Contractor elects to utilize this irrigation system; then the Contractor shall accept total responsibility for ensuring that the system is satisfactorily adjusted and operated while utilized by the Contractor.
3. If an irrigation system is to be provided or design/built under this Contract, and if the Contractor elects to utilize this irrigation system; then the Contractor shall coordinate with the irrigation designer, installer and operator, and shall accept total responsibility for ensuring that the system is satisfactorily adjusted and operated while utilized by the Contractor.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Mixes: Proprietary seed mix as follows:

C. Lawn Turf Seed Mix:
1. Proportioned by weight as follows:
   a. 40 percent: equal proportions of 2 or more improved Kentucky bluegrass (Poa pratensis) varieties.
   b. 40 percent: equal proportions of 2 or more improved creeping red fescue (Festuca rubra) varieties.
   c. 20 percent: 1 or more improved variety of perennial ryegrass (Lolium perenne).

D. New England Wetmix:
1. Basis-of-Design Product: Subject to requirements, provide "New England Wetmix" produced by New England Wetlands Plants or a comparable product by the Chas. C. Hard Seed Company or Ernst Seed.
   a. Mix blend as indicated on the drawings and in proportions recommended by the producer.
   b. Nurse crop: as recommended by the producer.

E. New England Conservation/Wildlife Mix:
1. Basis-of-Design Product: Subject to requirements, provide "New England Conservation Wildlife Mix" produced by New England Wetlands Plants or a comparable product by the Chas. C. Hard Seed Company or Ernst Seed.
   a. Mix blend as indicated on the drawings and in proportions recommended by the producer.
   b. Nurse crop: as recommended by the producer.

2.2 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition:
    a. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition:
    a. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.3 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. 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.

C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

D. Straw Blanket: Short-term, single-net erosion control blanket consisting of 100 percent straw matrix with biodegradable natural fiber netting, conforming to Federal Highway Administration Standard Specifications FP-03, Article 713.17(d), Type 2.C.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    a. North American Green S75BN Single Net Erosion Control Blanket.

2.4 PESTICIDES

A. General: Pesticide, registered and approved by the 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 Nonselective): 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 Nonselective): Effective for controlling weed growth that has already germinated.

2.5 WATER

A. Suitable for irrigation, and free from ingredients harmful to plant life.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

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. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is 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 of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329115 "Soil Preparation (Performance Specification)."

B. Placing Planting Soil: Place manufactured planting soil over exposed subgrade.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting 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.

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed per the producers recommendations.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. 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.

E. Begin watering immediately.

3.5 HYDROSEEDING

A. Hydroseeding: Mix specified seed, commercial fertilizer or slow-release 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. Spray-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 cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

3.6 TURF MAINTENANCE

A. General: 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. Minimum watering requirement: Water for 15 to 30 minutes every other morning for a period of at least 2 weeks during cool weather, or for up to 6 weeks during hot dry weather. Continue watering not less than twice per week for at least 2 months following the date of seeding. Provide additional watering as needed, especially during hot dry weather.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third 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:
1. Mow lawn turf to a height of 2 to 3 inches.

D. Turf Postfertilization: Apply commercial fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen per the recommendations of the topsoil testing report.

2. Do not fertilize basin wetmix or conservations/wildlife seed mix areas.

3.7 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 any 10 sq. ft. 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.

3.8 WETMIX AND CONSERVATIONS/WILDLIFE SEED MIX

A. Prepare planting areas for soil placement. Mix and place planting soil according to Section 32 91 15 “Soil Preparation (Performance Specification).” Do not proceed with rain garden seeding until Drainage Engineer has approved rain garden soil mix placement.

B. Maintain a loose friable seed bed. At no time will rubber tired loaders or graders having greater compaction than a small farm tractor be allowed on planting soil. Keep all heavy equipment and trucks off prepared planting soil. Do not prepare while ground is wet or frozen.

C. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.

1. Before sowing, mix seed with seed carrier.
2. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
3. Do not use wet seed or seed that is moldy or otherwise damaged.

D. Seed detention basins when a minimum of 1/4 inch of natural rainfall is expected, or when a minimum of 1/4 inch of irrigation will be received within 10 days after seeding. If sufficient natural rainfall is not received within 10 days, the new seeding shall be irrigated with a minimum of 1/4 inch of water, or so that water penetrates the soil to a uniform minimum depth of 4.0 inches.

E. Sow seed at a total rate according to “Seeding” Article and as confirmed by seed mix supplier.

F. Brush seed into top 1/4 inch of soil, roll lightly, and water with fine spray.

G. Protect seeded areas with slopes exceeding 1:6, and other areas subject to concentrated water run-off, with straw blankets installed and stapled according to manufacturer's written instructions.

H. 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.

I. Water newly planted areas and keep moist until meadow is established.

3.9 WETMIX AND CONSERVATIONS/WILDLIFE SEED MIX

3.10 MAINTENANCE

A. Maintain and establish wetmix and conservation/wildlife mix areas by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable stand of grasses and wildflower plants. 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 new mulch and anchor as required to prevent displacement.
3. Apply approved treatments as required to keep detention basin 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 wetmix and conservation/wildlife mix areas 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 muddy or newly planted areas.

C. Mow weeds when they reach a height of 8 to 12 inches or whenever the weeds become 2 to 3 times taller than the meadow seedlings. Mow back to the height of the new seedlings. With each successive mowing, raise the blade height so as not to clip the seedlings. To reduce future weeds, mow before weeds set seeds. Use flail-type mowers, and do not allow cuttings to cover and smother the seedlings. Mowing frequency will be determined by the height and intensity of weed competition, and type of equipment used.

3.11 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to 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 Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

C. Do not apply pesticides to wetmix or conservation/wildlife mix seeded areas.

3.12 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. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. 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.

D. Remove nondegradable erosion-control measures after grass establishment period.

E. Remove temporary irrigation system for plant establishment within 18 months of installation

3.13 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" and “Wetmix Conservation/Wildlife Mix Maintenance” Articles. 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 Lawn: 90 days from date of planting acceptance, or upon Substantial Completion of the Contract, whichever occurs later. Maintenance Service for seeded turf shall include a minimum of 8 mowings.

2. Provide Maintenance Service until acceptable turf is established throughout all turf areas. Turf areas will not be accepted individually.
3. 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. Wetmix and Conservation/Wildlife Mix Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Wetmix and Conservations/Wildlife Mix Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable stand of grasses and wildflowers is established, but for not less than maintenance period below.

C. Maintenance Period: 180 days from date of planting completion.

END OF SECTION 329200

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SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plant materials.
2. Fertilizers.
3. Mulches.
4. Herbicides and pesticides.
5. Tree-stabilization materials.
6. Landscape edgings.
7. Maintenance strip stone
8. Stone for filter strip
9. Geotextile fabric
10. Tree-watering devices.

B. Related Requirements:

1. Section 015639 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

1.2 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 a 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. Central Leader: A continuation of the main trunk located more or less in the center of the crown, beginning at the lowest main branch (scaffold) and extending to the top of the tree. Also referred to as the Dominant Leader.

D. Codominant: Two or more vigorous, upright branches or stems of relatively equal size that orginate from a common point, usually where the leader was lost or removed.

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. Crown: The portion of a tree beginning at the lowest main (scaffold) branch extending to the top of the tree.

G. Finish Grade: Elevation of finished surface of planting soil.

H. Included Bark: Bark embedded in the union between a branch and the trunk or between two or more stems that prevents the formation of a normal branch bark ridge.

I. Nursery: A place where young trees and plants are grown commercially for sale. Not included in this definition are horticultural distribution centers and plant re-wholesalers.

J. Planting Area: Areas to be planted.

K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 32 91 15 "Soil Preparation (Performance Specification)" for drawing designations for planting soils.

L. 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.

M. 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.

N. Scaffold Branches: Large main branches that form the main structure of the crown.

O. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

P. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.3 Trunk: The main stem of a tree, beginning at the root collar and ending at the lowest main scaffold branch.

1.4 REFERENCE STANDARDS

A. American Horticulture Industry Association d/b/a AmericanHort. Ph. (614) 487-1117. www.AmericanHort.org.
1. ANSI Z60.1: American Standard for Nursery Stock (2014).

1.5 COORDINATION

A. Coordination with Turf and seeded Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.7 ACTION SUBMITTALS

A. Nursery Source Tagging Submittals
   1. Nursery Sources: Within 30-days of the Contract start, submit a list of all proposed nursery sources for approval, confirming the availability of plant varieties, sizes, forms, and quantities indicated in the Contract Documents. For field-grown trees and plants, specified as "balled and burlapped", include photographs of the available plant blocks to confirm that the nurseries have a sufficient selection of satisfactory plants available for tagging. Provide the names and telephone numbers for the nurseries' representatives.
      a. Substitutions: Substitutions of plant material will not be permitted unless approved in writing by the Landscape Architect. If any specified plants are not available at the time when needed to meet the project schedule, submit a statement documenting the nursery sources investigated and providing proposals for equivalent plants of the nearest available size or similar variety. Substitutions will not be allowed if the Landscape Architect identifies alternate nursery sources within a 600 mile radius of the project site.
      b. Container grown plants shall not be substituted for plants designated "B&B" on the Plant Schedule, unless approved in writing by the Landscape Architect.
      c. Quantities: Quantities shown on the Plant Schedule are for information only. Provide every plant shown on the Drawings. In the event of a discrepancy between the Planting Plans and the written quantities in the Plant Schedule, the Planting Plan shall govern.
   2. Planting Schedule: Submit the projected planting schedule, including nursery visits, digging, delivery, storage and installation dates for review and approval. Schedule the dates for each type of landscape work during normal seasons for such work in each area of the site. Correlate with specified maintenance periods to provide maintenance until conclusion of the planting establishment and maintenance period. Revise schedule to keep current, subject to the Landscape Architect's approval.
   3. Nursery Visit Schedule: Coordinate with the Landscape Architect and the proposed nurseries to arrange nursery visits. The final schedule for nursery visits shall be submitted not later than the November 30 preceding the scheduled installation of the plants.

B. Product Data: For each type of product.
   1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
   2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from multiple angles 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 and horticultural variety of the plant, plant size, and name of the growing nursery.
      a. Field-grown trees and shrubs:
         1) Specimen trees: Three photographs of every individual specimen tree, taken from multiple angles.

2) Trees and shrubs to be furnished in quantities of 10 or less: At least three photographs of a typical plant taken from multiple angles, plus photographs showing overall views of the blocks from which the plants are to be obtained.
3) Trees and shrubs to be furnished in quantities greater than 10: Photographs of the average plant, the best quality plant, and the worst quality plant; plus photographs showing overall views of the blocks from which the trees are to be obtained.

b. Container-grown trees: Three photographs of each individual tree.
c. Container-grown shrubs and vines: One photograph of one typical plant.
d. Perennials and grasses: Photographs are not required.

C. Samples for Verification: For each of the following:
1. Organic Mulch: 1-quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.

1.8 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports: Percolation tests for tree pits. Include the following:

1. Tree identification number matching the plans.
2. Date of test.
3. Time when water was added to tree pit to start percolation test.
4. Time with photo documentation showing increments of testing with water level in tree pit.
5. Identification of tester.

B. Qualification Statements: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

C. Product Certificates: For each type of manufactured product, from manufacturer, and complying with manufacturer's certified analysis of standard products.

D. Pesticides and Herbicides: Product label and manufacturer's written application instructions specific to Project.

E. Sample Warranty: For special warranty.

1.9 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.10 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Member in good standing of either the National Association of Landscape Professionals or AmericanHort.
2. Experience: Five years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
3. Installer's Field Supervision: Maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certification: Installer's field supervisor certified in one of the following categories from the National Association of Landscape Professionals:

    a. Landscape Industry Certified Technician - Exterior.
    b. Landscape Industry Certified Horticultural Technician.

5. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

C. Measurements: Measure in accordance with ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Inspection and Tagging: It is the prerogative of the Architect to inspect and select all plant material at the grower’s nursery prior to digging and upon delivery to the project site, for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
1. Plants are subject to inspection and selection for overall form, vigor, and condition by the Architect with the Installer at the nursery source or place of growth. Plants designated as “balled and burlapped” shall be field-grown, and shall not be dug until inspected, approved and sealed by the Architect.
2. The Installer shall accompany the Architect on all source inspections, and shall make all necessary arrangements, provide transportation, and pay all expenses including travel, food, and lodging.
3. Coordinate with approved nurseries and with the Architect to schedule the Architect’s nursery visits, to secure approved plants, and to confirm digging and shipping dates in conformance with the approved planting schedule. Arrange nursery visits as far in advance of the scheduled installation as possible, which will typically occur during the period running from September through February preceding the installation. In northern and snow-belt nurseries that are expected to become inaccessible during the winter,

tagging shall be scheduled for completion prior to the onset of winter conditions. All tagging shall be completed by February 28. Summer and fall digging of deciduous plants will not be permitted without the Architect's approval.

4. All plants shall be delivered to the site with the Architect's permanent seals intact.

1.11 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 compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, or 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 materials with appropriate certificates.

C. All plants shall be prepared and packed, and protected to ensure arrival at the site in good condition. They shall arrived fresh and properly dug, in sound, healthy, vigorous condition with healthy and well-developed tops and root systems, and with all parts moist and showing active green cambium when cut.

D. 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.

E. Handle planting stock by root ball.

F. Apply antidesiccant 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 antidesiccant at nursery before moving and again two weeks after planting.

G. 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.

H. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Set balled stock on ground and cover ball with mulch.
2. Do not remove container-grown stock from containers before time of planting.

3. 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.

1.12 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Preliminary Acceptance. Planting shall progress only under favorable weather conditions and will not be permitted when the ground is frozen or excessively moist.
   1. Plant within the following recommended periods to provide optimal conditions for successful recovery from transplanting stresses.
      a. Plant deciduous plants: April 1 to May 30, and August 15 until the ground freezes.
      b. Spring planting may be extended until June 15 if a well-monitored irrigation system is in use.
      c. Plant evergreen plants: April 1 to June 15, and August 15 to October 15.
      d. Perennials and ornamental grasses: April 1 to May 30, and September 1 to September 15.
      e. Bulbs: From September 1 until the ground freezes.
   2. If special conditions exist to justify a variance in the above planting dates, submit a written request to the Landscape Architect stating the special conditions and the proposed variance. Describe techniques in addition to those specified herein that will be employed to prevent dieback and mortality. No waiver of the plant guaranty will be granted for planting performed out-of-season.

C. 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 in accordance with manufacturer's written instructions and warranty requirements.

D. Watering: The Installer shall bear sole responsibility for furnishing and applying all irrigation water, irrespective of whether or not an irrigation system is installed or operable. The Installer shall ensure that all irrigation water is applied at the proper frequency, coverage, and in proper amounts to fulfill the plant establishment and maintenance requirements of the Contract. The Installer’s responsibility for all watering shall begin upon delivery of plants the site, and shall continue through the end of the Warranty Period.
   1. If not irrigation system is available, or if an available irrigation system is unsatisfactory to the Installer’s needs, then the Installer shall furnish and apply all irrigation water.
   2. If an irrigation system is made available for the Installer’s use, and if the Installer elects to utilize this irrigation system; then the Installer shall accept total responsibility for ensuring that the system is satisfactorily adjusted and operated while utilized by the Installer.

E. If an irrigation system is to be provided or design/built under this Contract, and if the Installer elects to utilize this irrigation system; then the Installer shall coordinate with the irrigation

designer, installer, and operator, and shall accept total responsibility for ensuring that the system is satisfactorily adjusted and operated while utilized by the Installer.

1.13 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.
    b. Structural failures, including plantings falling or blowing over.
    c. Faulty performance of tree stabilization and edgings.
    d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
2. Warranty Periods: From date of Preliminary Acceptance of planting or upon Substantial Completion of the contract, whichever occurs later.
    a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months, except that deciduous plants in a dormant condition on the date the warranty commences will be warranted for an additional period extending through June 1 of the next following spring
    b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
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. Replace plants that have bark scald; foliage of abnormal density, size, and color; or that have more than 25 percent dead or dying branches and branch tips.
    c. Provide extended warranty for period equal to original warranty period, for replaced plant material.

1.14 ACCEPTANCE

A. The Landscape Architect will inspect all plant material for acceptance upon written request of the Installer. The request shall be received at least 10 calendar days before the anticipated date of inspection.

B. Acceptance of plant material will be granted for general conformance to the specified size, character, and quality, but will not relieve the Installer of responsibility for full conformance to the Contract Documents, including correct species.

C. Upon completion and re-inspection of all repairs or renewals necessary in the judgment of the Landscape Architect, the Landscape Architect will certify in writing that the plant material has been preliminarily accepted.

1.15 FINAL INSPECTION AND FINAL ACCEPTANCE

A. At the end of the Maintenance Period and upon written request of the Installer, the Landscape Architect will inspect all plant material for final acceptance. The request shall be received at least 10 calendar days before the anticipated date of inspection. Upon completion and re-inspection of all repairs and renewals necessary in the judgment of the Landscape Architect at that time, the Landscape Architect will certify in writing that the plant material has received final acceptance.

PART 2 - PRODUCTS

2.1 PLANT MATERIALS

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings 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; with tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); with crossing trunks; with cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.
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.
3. Plants shall have been grown under climatic conditions similar to those of the project site.
4. Balled and burlapped plants shall be moved as solid units having firm natural balls of soil of sufficient size to encompass the fibrous and feeding root system to ensure full and prompt plant recovery. Plants with loose, manufactured, cracked, broken, or undersized balls will be rejected.

B. Form and Structure: Unless indicated otherwise in Plant List shown on Drawings, deciduous and evergreen trees shall comply with the following;
1. Habit of growth shall be typical of the species or variety; heavy, symmetrical, well branched and proportioned, and densely foliated when in leaf.
2. Trees shall have a single, relatively straight vertical trunk and central leader. Deciduous shade trees shall be free of major branches up to a height of at least 6-feet unless otherwise specified. Evergreen and clump-form trees shall have dense compact growth branched to the ground unless otherwise specified.
3. Trees shall be free of codominant stems and vigorous, upright branches that complete with the central leader. If the original leader has been headed, a new leader at least one-half of the diameter of the original leader shall be present.
4. Main branches shall be well-distributed along the central leader, and not clustered together. They shall form a balanced crown appropriate for the cultivar or species.
5. Branch diameter shall be no larger than two-thirds (one-half is preferred) the diameter of the central leader measured 1 inch above the branch.
6. The attachment of the largest branches (scaffold branches) shall be free of included bark.

C. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

D. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

E. 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.

F. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.2 FERTILIZERS

A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
   1. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

B. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb of ectomycorrhizal fungi, 33 percent hydrogel, and maximum of 5.5 percent inert material.

2.3 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
   1. Type: Double-shredded softwood bark composed primarily of pine and spruce bark. Aged not less than 9 months. Sample to be approved.
   2. Color: Natural, un-dyed.

2.4 HERBICIDES AND PESTICIDES

A. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

B. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

C. Pesticides: Registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended in writing 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.

2.5 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
2. Guys and Tie Wires: ASTM A641/A641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter.
3. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
4. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.
5. Proprietary Staking-and-Guying Devices: Proprietary stake or anchor and adjustable tie systems to secure each new planting by plant stem; sized as indicated and in accordance with manufacturer's written instructions.

2.6 LANDSCAPE EDGINGS

A. Aluminum Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.
1. Edging Size: 1/8 inch thick by 5 1/2 inches deep.
2. Stakes: Tapered, a minimum of 12 inches long.
3. Accessories: Standard tapered ends, corners, and splicers.
4. Finish: milled aluminum.

2.7 MAINTENANCE STRIP STONE

A. Crushed stone to be used for maintenance strips.

B. Hard, durable, smooth stone, washed free of loam, sand, clay and other foreign substances.
1. Stone Sizes: 3/4-inch crushed stone.
2. Color: to be selected by Landscape Architect, blend of tans and greys to complement building finishes.

2.8 FILTER STRIP STONE

A. Rounded river stone to be used for maintenance strips where noted on Drawings.

B. Hard, durable, smooth and rounded stone, washed free of loam, sand, clay and other foreign substances.
1. Stone Sizes:
   a. Maintenance Strip (where noted on Drawings): 2 inch minimum to 3 inch maximum.
   b. Rain Garden Curb Cuts: 3 inch minimum to 5 inch maximum.
   c. Stone Filter Strip: 3 inch minimum to 5 inch maximum.
2. Color: to be selected by Landscape Architect, blend of tans and greys to complement building finishes.

2.9 GEOTEXTILE

A. For separation and drainage, complying with Connecticut Department of Transportation Standard Specifications for Roads, Bridges, Facilities and Incidental Construction Form 818, M.08.01-19.

B. Staples for use in securing geotextile: 4” x 1” x 4” wire staple.

2.10 TREE-WATERING DEVICES

A. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over an extended time period; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

1. Color: green.

2.11 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix in accordance with manufacturer's written instructions.

B. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

C. Deer Repellant: Commercial product with documented deer-deterrent properties.

D. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D448 for Size No. 8.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

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. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
3. Suspend planting operations during periods of excessive soil moisture until moisture content reaches acceptable levels to attain required results.
4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove soil and contamination as directed by Architect and replace with new planting soil.

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

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 Architect's acceptance of layout before excavating or planting. Make adjustments as directed.
   1. Plant locations on the Drawings are approximate and are to be used only as a guide. Installer shall accurately stakeout plant locations and bed outlines. Do not begin planting excavations until the Landscape Architect has approved or adjusted the stakeouts. Prior to installation, modify plant locations within the project area as directed by the Architect without additional cost to the Owner.
   2. Unless otherwise indicated, massed plantings and rows of shrubs, perennials, and grasses are to be installed in a staggered triangular or diagonal configuration. Straight, square rows will not be accepted.

3.3 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil in accordance with Section 329115 "Soil Preparation (Performance Specification)."

B. Placing Planting Soil: Place manufactured planting soil over exposed subgrade.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

D. Application of Mycorrhizal Fungi: At time directed by Architect, broadcast dry product uniformly over prepared soil at application rate in accordance with manufacturer's written instructions.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

   1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
   2. Excavate approximately three times as wide as ball diameter for balled and burlapped and container-grown stock.

3. Do not excavate deeper than depth of root ball, measured from the root flare to the bottom of root ball.
4. If area under the plant was initially dug too deep, add soil to raise it to correct level and thoroughly tamp the added soil to prevent settling.
5. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
6. Maintain supervision of excavations during working hours.
7. Keep excavations covered or otherwise protected when unattended by Installer's personnel.

B. Continuous Planting Beds for Shrubs:
1. Excavate shrub beds to a minimum depth of 18” with sides sloping inward at a 45-degree angle. Loosen subgrade by dragging with teeth of bucket 3” to 6” deep. Install first lift of planting soil immediately and do not allow loosened subgrade to become compacted.
2. Install planting soil in 2 equal lifts. Compact each lift to a minimum of 75 percent and a maximum of 82 percent of Standard Proctor Density. Scarify between lifts by dragging with the teeth of bucket.
3. Excavate circular planting pits in continuous beds aft the planting soil has been installed in continuous beds.

C. Backfill Soil: Subsoil and topsoil removed from excavations may not be used as backfill soil unless otherwise indicated.

D. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6-inch-diameter holes, 24 inches apart, into free-draining strata or to depth of 10 ft., whichever is less, and backfill with free-draining material.

E. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

F. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball in accordance with ANSI Z60.1. If root flare is not visible, remove soil in a level manner from root ball to where the top-most root emerges from the trunk. After soil removal to expose root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 3 inches above adjacent finish grades.

1. Backfill: Planting soil Type 1, 2 or 3.

2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
    a. Quantity: According to manufacturer's written recommendations.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.

1. Backfill: Planting soil Type 1, 2 or 3.
2. Carefully remove root ball from container without damaging root ball or plant.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
    a. Quantity: According to manufacturer's written recommendations.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of root ball.

3.6 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape unless otherwise directed by Architect.

B. Do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

C. Make clean cuts as close as possible to the trunk or parent branch without cutting into the branch collar or leaving a stub.

D. Do not apply pruning paint to wounds.

3.7 INSTALLATION OF TREE-STABILIZATION MATERIALS

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying:

    a. Stake trees of 2- 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 to extend to the dimension indicated on Drawings above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
2. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

B. Trunk Stabilization by Staking and Guying: Install trunk stabilization as follows unless otherwise indicated on Drawings. Stake and guy trees more than 14 ft. in height and more than 3 inches in caliper unless otherwise indicated.

1. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and in accordance with manufacturer's written instructions.

3.8 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.

B. Use planting soil Type 1, 2 or 3 for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.9 INSTALLATION OF MULCHES

A. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees and Treelike Shrubs in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with a radius around trunks or stems. Do not create a mulch cone or place mulch within 6 inches of trunks or stems.
2. Organic Mulch in Planting Areas: Apply 2-inch average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.10 INSTALLATION OF LANDSCAPE EDGINGS

A. Steel Edging: Install steel edging where indicated in accordance with manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.

B. Shovel-Cut Edging: Separate mulched areas from turf areas, curbs, and paving with 45-degree, 4- to 6-inch-deep, shovel-cut edge.

C. Mow-Strip Installation:

1. Excavate for mow strip as indicated on Drawings.
2. Compact subgrade uniformly beneath mow strip.
3. Apply nonselective, pre-emergent herbicide that inhibits growth of grass and weeds.
4. Install steel edging, delineating the edge of mow strip.
5. Install geotextile fabric before stone surfacing, covering area of mow strip, and overlapping and pinning edges of barrier at least 6 inches and in accordance with manufacturer's written instructions.
6. Place indicated thickness of mineral mulch, fully covering weed barrier.
7. Rake mulch to uniform surface level with adjacent finish grades.

3.11 INSTALLATION OF MAINTENANCE STRIP

A. Excavate to lines, grades and depths as specified on the Drawing.

B. Compact subgrade uniformly beneath areas to receive aggregate surfacing.

C. Install edging where indicated and according to manufacturer’s written instructions. Anchor with stakes to hold edge restraints in place during and after aggregate installation and spaced according to manufacturer’s written instructions, driven below top elevation of edging.

D. Install geotextile, covering area to receive aggregate surfacing and wrap up sides as indicated on Drawings, over-lapping and pinning edges of geotextile at least 6 inches and according to manufacturer’s written instructions.

E. Place indicated thickness of aggregate fully covering the geotextile. Rake aggregate to a uniform surface level with adjacent finish grades, unless otherwise indicated on Drawings.

3.12 INSTALLATION OF TREE-WATERING DEVICES

A. Provide one device for each tree.

B. Place device on top of the mulch at base of tree stem and fill with water in accordance with manufacturer's written instructions.

3.13 APPLICATION OF HERBICIDES AND PESTICIDES

A. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written instructions. Do not apply to seeded areas.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written instructions.

C. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and in accordance with manufacturer's written instructions. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.14 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices acceptable to authorities having jurisdiction. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

D. Heavily water woody plants in late fall, after leaf drop and before the ground freezes.

E. Provide early spring clean-up of perennial and ornamental grass beds before new growth starts. Cut back and remove dead top growth, repair damage, remove weeds, refresh mulch, and re-edge beds.

F. Protect plants from deer damage, including regularly monitoring deer activity and timely applications of deer repellants and barriers.

G. Upon Final Acceptance at end of Maintenance Period, remove tree-stabilization devices and planting saucers. Dress with mulch.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Perform tree pit percolation tests.
2. Tree pit construction will be considered defective if it does not pass percolation tests and inspections.
3. Do not proceed with planting in tree pits until satisfactory percolation is demonstrated.

C. Prepare test and inspection reports.

3.16 REPAIR AND REPLACEMENT

A. Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Remove and replace trees that are more than 25 percent dead or in unhealthy condition before end of corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

1. Provide new trees of same size as those being replaced for each tree of 6 inches or smaller in caliper size.
2. Species of Replacement Trees: Same species being replaced.

3.17 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Preliminary Acceptance, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

E. Remove any temporary irrigation systems for plant establishment within 18 months of the start of the Maintenance Period.

3.18 MAINTENANCE SERVICE

A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: 12 months from date of Preliminary Acceptance or upon Substantial Completion of the contract, whichever occurs later.

B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin

maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: 12 months from date of Preliminary Acceptance or upon Substantial Completion of the contract, whichever occurs later.

END OF SECTION 329300

SECTION 331100 – WATER UTILITY DISTRIBUTION PIPING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes water-distribution piping and related components including connection to approximately 5 feet outside the building for water service and fire-service mains.

B. Contractor shall coordinate any utility-furnished products include water meters.

C. Water pipe smaller than 4" is to be copper pipe Type K. All other water pipe to be ductile iron class 52.

D. The Contractor is responsible for any water connection fees.

E. The Contractor is to provide engineered drawings for each thrust block location.

F. Related Work Specified in Other Sections:

1. Section 312000 Earth Moving

G. All work shall be in accordance with Metropolitan District Commission (MDC) and Connecticut Plumbing Code Regulations.

1.03 REFERENCED STANDARDS

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.

B. American Society for Testing and Materials (ASTM)

1. ASTM E548: Generic Criteria for Use in Evaluation of Testing and Inspection Agencies

C. American Water Works Association (AWWA)

1. AWWA B300: Hypochlorites
2. AWWA B301: Chlorine – Liquid
3. AWWA C500: Gate Valves 3 through 48-inch NPS, for Water and Sewage Systems
4. AWWA C601: Disinfection Water Mains

D. National Fire Prevention Association (NFPA).

1. NFPA No. 24: Private Fire Service Mains

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's specifications and installation instructions for all products specified in this section, including pipes and valves. Obtain MDC approvals prior to submittal to the Architect.

B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

C. Hydrostatic testing plan

D. Flushing and disinfection testing plan

E. Field quality-control test reports

F. Operation and maintenance data: For water valves and specialties to include in emergency, operation, and maintenance manuals

G. Disposal method: Submit to the owner the proposed method for disposal of wastewater from flushing, hydrostatic testing and disinfection a minimum of 10 working days before performing flushing

H. Thrust block drawings

I. As-built drawings

1.05 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Form 818 - State of Connecticut Department of Transportation "Specifications for Roads, Bridges, Facilities and Incidental Construction" 2020 edition, and latest supplements, shall be used for materials compliance and execution of the work in this section, unless otherwise specified herein.
2. Comply with requirements of the MDC, including tapping of water mains and backflow prevention.
3. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
4. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

B. Insurance Requirements: All water system products shall meet the requirements of the Owner's insurance underwriters.

C. Testing and Inspection Agency Qualifications: An independent testing agency approved by the Architect and acceptable to the town. Testing laboratory approval will be based on compliance with ASTM E548.

Testing of compacted fill materials shall be performed by an independent testing laboratory.

When work of this section or portions of work are completed, the contractor notifies their testing laboratory to perform density tests. Do not proceed with additional portions of work until results have been verified.

If, during progress of work, tests indicate that compacted materials do not meet specified requirements, notify the Inspector as to direction to proceed. If required by the Inspector, remove the defective work, replace and retest.

Ensure compacted fills are tested before proceeding with placement of surface materials.

Examine existing and finish grades as shown on grading plan and excavation and fill as indicated on plans and elevations. Protect and maintain site boundaries and project limits during construction. If disturbed, destroyed or exceeded, repair as directed.

D. Piping materials shall bear label, stamp, or other markings of specified testing agency.

E. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

F. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

G. NFPA Compliance: Comply with NFPA 13, 2002 edition**,** for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

H. NSF Compliance: Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping 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.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

1.07 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution 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 water-distribution service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than five days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without Owner's written permission.

1.08 COORDINATION

A. Coordinate connection to water main with the MDC. Water main connections may need to be performed at Owner's discretion.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

A. Ductile iron pipe: Ductile iron pipe shall be designed in accordance with ANSI A21.50 and shall be manufactured in accordance with ANSI A21.51, pipe class 52. Pipe shall be cement mortar in accordance with ANSI A21.4. Linings shall be standard.

B. All pipe smaller than diameter shall be copper Type K.

1. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper

a. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
b. Joints in copper tubing shall be made with three part compression couplings, flared tube fittings (ASA spec. B-16), or an approved equal. All fittings shall be electrically conductive.

2. Hard Copper Tube: ASTM B 88, Type K water tube, drawn temper

a. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
b. Joints in copper tubing shall be made with three part compression couplings, flared tube fittings (ASA spec. B-16), or an approved equal. All fittings shall be electrically conductive.

C. Mechanical-Joint, Ductile-Iron Pipe: Class 52, cement mortar lined, AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated. Fittings and specials for use with mechanical joint type pipe shall conform to ANSI A21.10, Class 250.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
3. Restrained joint devices by Megalug or approved equal. Glands and restraining devices manufactured of ductile iron conforming to ASTM A536-80. Working pressure not less than 350psi.

D. Push-on-Joint, Ductile-Iron Pipe: Class 52, cement mortar lined, AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern
2. Gaskets: AWWA C111, rubber

2.02 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Reductions in pipe sizes shall be made with one piece reducing fittings of approved pattern meeting specifications requirements. Bushings will not be acceptable as reducing fittings.

C. Tubular-Sleeve Pipe Couplings:

1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.

a. Standard: AWWA C219

2.03 GATE VALVES

A. Per authorities having jurisdiction.

B. All gate valves shall be mechanical joint resilient-seated valves, open left, non-rising stem, 200 Psi working pressure, O-ring seals, iron body, bronze mounted, parallel seat with accessories, and shall meet or exceed ASNI/AWWA C509a-95 or its latest revision and shall be manufactured by one of the following: Kennedy Valve, American Valve & Hydrant, M+H Valve Co., Waterous, Mueller, American AVK Co., or U.S. Pipe Company's "METRO-SEAL", Clow.

2.04 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

1. Description: Sleeve and valve compatible with drilling machine.

a. Standard: MSS SP-60
b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.

c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

2.05 CORPORATION VALVES AND CURB VALVES

A. Per MDC and the Town of Bloomfield.

2.06 FIRE HYDRANTS

A. Per MDC and the Town of Bloomfield.

B. Fire Hydrants: Furnish dry barrel type conforming to AWWA C502, with a valve opening of at least 5-1/4 inches in diameter, with bronze working parts, and with the following connections:

1. One 6-inch bell connection
2. Two 2-1/2-inch hose connections
3. One 4-1/2-inch pumper connection

C. Furnish fire hydrants which conform to the requirements of the local fire department and water department. It is the responsibility of the Contractor to determine local fire and water department requirements. Items requiring conformance include the following.

1. Hose thread sizes
2. Size and configuration of operating and nozzle cap nuts
3. Turning direction to open hydrants
4. Acceptable Manufacturers

D. Finish: One coat of rust-inhibitive primer and two coats of exterior enamel paint. Color shall be as directed by the Fire Department.

2.07 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connections shall be according to regulations of MDC and the Town of Bloomfield. Provide minimum 3-feet of clearance around the entire fire department connection. Install wall-mounted fire department connections as shown on mechanical drawings.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.02 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

3.03 PIPING INSTALLATION

A. Water-Main Connection: Tap water mains according to requirements of MDC and of size and in location indicated.

B. Make connections larger than NPS 2 with tapping machine according to the following:

1. Install tapping sleeve and tapping valve according to MSS SP-60.
2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

C. Make connections NPS 2 and smaller with drilling machine according to the following:

1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
4. Install corporation valves into service-saddle assemblies.
5. Install manifold for multiple taps in water main.
6. Install curb valve in water-service piping with head pointing up and with service box.

D. Comply with NFPA 13, 2002 edition, for fire-service-main piping materials and installation.

1. Install copper tube and fittings according to CDA's "Copper Tube Handbook."

E. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

F. Bury piping with depth of cover over top as shown on the plans or as directed.

G. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.

1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

3.04 JOINT CONSTRUCTION

A. Make pipe joints according to the following:

B. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.

C. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.

D. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.

3.05 ANCHORAGE INSTALLATION

A. Anchorage, General: Shall be according to authorities having jurisdiction.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
2. Fire-Service-Main Piping: According to NFPA 13, 2002 edition.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.06 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. UL/FMG, Gate Valves: Comply with NFPA 13, 2002 edition. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

C. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

3.07 FIRE HYDRANT INSTALLATION

A. Fire hydrants shall be installed according to methods prescribed by authorities having jurisdiction.

3.08 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests after concrete thrust blocks have hardened sufficiently. Fill pipeline slowly with water and exhaust all air before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test in accordance with AWWA C600, latest revision, at not less than one-and-one-half times working pressure or 150 psi, whichever is greater, for a minimum of two hours.

1. Testing allowance, or makeup water, shall be calculated per AWWA C600. Contractor shall provide a water meter with appropriate precision for measuring the amount of makeup water used during a hydrostatic test. Contractor shall also provide a test pressure gauge with pressure snubber that has factory marked increments of not more than 5 psi above and below the required test pressure.

C. Prepare reports of testing activities.

3.09 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 31 Section "Earth Moving."

3.10 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Use flushing and disinfecting procedure prescribed by authorities having jurisdiction, if applicable. Flush and disinfect all piping per ANSI/AWWA C651, latest revision. Submit proposed plan to Engineer for review and approval prior to beginning the work.

B. Prepare reports of flushing and disinfecting activities.

END OF SECTION 331100

SECTION 333100 – SANITARY UTILITY SEWERAGE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Work Included: All exterior piping, fittings, and structures as shown on the Drawings.

B. Related Work Specified in Other Sections.
   1. Section 31 21 00 Earthwork

C. All sewer work is to follow the Town of Bloomfield Water Pollution Control Authority (WPCA) and Department of Public Works regulations.

1.03 REFERENCED STANDARDS

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.

B. American Society for Testing and Materials (ASTM).
   1. ASTM A48: Standard Specification for Gray Iron Castings
   2. ASTM C32: Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
   3. ASTM C117 - 04 Standard Test Method for Materials Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing
   4. ASTM C136 – Method for Sieve Analysis of Fine and Coarse aggregates
   5. ASTM C150: Standard Specification for Portland Cement
   6. ASTM C270: Standard Specification for Mortar for Unit Masonry
   7. ASTM D1556 - 07 – Test Method for Density of Soil and Soil Aggregate in Place by the Sand Cone Method
   8. ASTM D1557 - 09 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (Modified Proctor Test)
   9. ASTM D2922 – Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Method (Shallow Depth)
   10. ASTM D3017 – Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
   11. ASTM D422 – Method for Particle Size Analysis of Soils
   12. ASTM E548: Generic Criteria for Use in the Evaluation of Testing and Inspection Agencies

C. Occupational Safety and Health Administration (OSHA): Regulations, 29 CFR Part 1926 - Including, but not limited to, Excavations and Excavation Support, Current Revision.

1.04 SUBMITTALS

A. Product data for pipe, manholes, frames grease trap, and castings.

B. Shop Drawings: Include manhole openings, covers, pipe connections, and accessories for the following precast structures:

C. Product Data: Broken stone are imported backfill materials.

D. As-built Drawings: Show pipe sizes, locations, and elevations.

E. Testing Plan

F. Field quality-control test reports for each test to be submitted within 3 working days after test completion.
   1. Alignment test
   2. Air test
   3. Manhole vacuum test

1.05 QUALITY ASSURANCE

A. Testing and Inspection Agency Qualifications: An independent testing agency approved by the Architect and acceptable to the Town of Bloomfield. Testing laboratory approval will be based on compliance with ASTM E 548.

   When work of this section or portions of work are completed, the contractor notifies their testing laboratory to perform density tests. Do not proceed with additional portions of work until results have been verified.

   If, during progress of work, tests indicate that compacted materials do not meet specified requirements, notify the Inspector as to direction to proceed. If required by the Inspector, remove the defective work, replace, and retest.

   Ensure compacted fills are tested before proceeding with placement of surface materials.

   Examine existing and finish grades as shown on grading plan and excavation and fill as indicated on plans and elevations. Protect and maintain site boundaries and project limits during construction. If disturbed, destroyed or exceeded, repair as directed.

B. Workers: all workers shall be thoroughly trained and experienced in the necessary crafts, and completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

C. Form 818 - State of Connecticut Department of Transportation "Specifications for Roads, Bridges, Facilities and Incidental Construction" 2020 edition, and latest supplements, shall be used for materials compliance and execution of the work in this section, unless otherwise specified herein.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Pipe and fittings shall be inspected upon delivery and before being installed. Damaged pipe and fittings shall be removed from the work site, and shall be replaced at no additional cost to the Owner.

B. Inside of pipes and fittings shall be kept free of dirt and debris. Plug pipe and fitting ends.

C. Plastic pipe shall be protected from exposure to direct sunlight over extended periods.

D. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any other materials required to install the plastic pipe shall be stored in accordance with the manufacturer's recommendation and shall be discarded if the storage period exceeds the recommended shelf life.

1.07 SITE CONDITIONS

A. Site information: Perform site survey, research public utility records and verify existing utility locations. Verify that the sanitary sewage system may be installed in compliance with the original design and standards.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

2.02 BACKFILL AND BEDDING MATERIAL

A. Bedding Material: Shall conform to the Town of Bloomfield and Form 818 requirements, and as indicated on the Contract Drawings.

B. Backfill Material: Shall conform to the Town of Bloomfield and Form 818 requirements, shall be friable soil, free of rubbish, ice, snow, tree stumps, roots, clay and other organic matter; no stone greater than two thirds loose lift thickness, and shall not contain a high moisture content.

2.03 Polyvinyl Chloride Pipe, Joints and Fittings

A. Gravity Sewer Pipe:
   1. Sizes 4-inch through 8-inch diameter: Polyvinyl chloride (PVC) pipe shall conform to ASTM D 3034, Type PSM with a SDR of 35.
   2. Joints shall conform to ASTM D 3212, elastomeric gasket type. Gaskets shall conform to ASTM F 477.
   3. Fittings shall conform to ASTM D 3034, Type PSM with a SDR of 35.
   4. Branch connection shall be made by use of regular fittings or solvent cemented saddles as approved by Architect. Saddles for PVC pipe shall comply with Table 4 of ASTM D 3034.

2.04 PVC PIPE AND FITTINGS

A. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

2.05 NONPRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Cast-Iron Soil Pipes: ASTM C 564, rubber
   2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC
   3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined

C. Shielded, Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Ring-Type, Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.06 MANHOLES

A. Manholes shall be of precast concrete. Precast concrete sections shall conform to ASTM C478, except that Portland cement shall conform to ASTM C 150, Type IIA. Concrete shall have a minimum compressive strength of 4000 psi at 28 days.
   1. Joints for precast reinforced concrete manhole sections shall be O-ring rubber gaskets or compressible filler such as Kent Seal No. 2 joint sealant or approved equal.
   2. Exterior surfaces of manholes shall be painted with two coats of Bitumastic No. 28 as manufactured by Koppers Company, or approved equal.

B. Brick: ASTM C 32, Grade MS.

C. Mortar: Portland cement mortar, ASTM C 270, Type M. Use ASTM C 150, Type IIA cement.

D. Frames and covers: Frames and covers shall be in accordance with the Town of Bloomfield WPCA requirements. The frames and covers shall have a combined weight of not less than 400 pounds and shall conform to ASTM A 48, Class 20B.

E. Manhole Steps: Dropfront type rung of steel reinforced co-polymer polypropylene plastic.
   1. Steps: 1-3/16 inches in diameter, with 14 inches of width, and project a minimum of 5- 1/8 inches from the inside face of the manhole.
   2. Reinforcing Steel: Grade 60 and 1/2 inch in diameter.

F. Pipe Connections: ASTM C 443. Manufactured manhole connections shall be neoprene boot, 3/8 inch minimum thickness, as manufactured by Kor-N-Seal, or approved equal.

G. Cement mortar parging: Cement mortar shall conform to ASTM C 150, Type IIA cement.

H. Additional materials for adjustment grade of existing structures:
1. Precast concrete adjustment rings: Concrete shall have a minimum compressive strength of 5000 psi at 28 days. Steel reinforcement shall conform to ASTM A615. Grade 60 and shall have 1-inch minimum cover.
2. Heavy duty manhole adjustment rings shall be Neenah R-1979 series or approved equal.

2.07 CONCRETE

A. Cast-in-place concrete according to ACI 318/318R, ACI 350R, 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. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel

C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

A. Pipe couplings and 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 couplings for same or minor difference OD pipes.
b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

B. Gravity-Flow, Nonpressure Sewer Piping:
1. NPS 3 and NPS 4: NPS 4 PVC sewer pipe and fittings, gaskets, and gasketed joints.

3.02 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Adjacent water service:
1. Where the location of the sewer line is not clearly defined by dimensions on the Drawings, the sewer shall not be closer horizontally than 10 feet to a water service line except that

where the bottom of the water pipe will be at least 18 inches above the top of the sewer pipe.

2. Where gravity flow sewers cross above water lines with less than 18 inches of vertical separation, the sewer pipe for a distance of 10 feet on each side of the crossing shall be fully encased in concrete or shall be of pressure pipe, as approved by the Engineer, with no joint closer horizontally than 3 feet to the crossing. The thickness of the concrete encasement including that at the pipe joints shall not be less than 4 inches to pipe.

C. Trenches shall be kept free of water and as dry as possible during bedding, laying, and jointing and for as long a period as required. Pipe shall not be laid in water or when trench conditions are unsuitable for the work.

D. Each pipe shall be laid accurately to the line and grade shown on the Drawings.

E. Pipe laying will not be allowed to begin at any point other than a manhole or other appurtenance.

F. Pipes entering or leaving manholes shall not exceed 2 feet in length as measured from the inside face of the manhole wall.

G. Pipes entering or leaving manholes shall extend a minimum of 1 inch into the manhole as measured from the inside face of the manhole wall.

H. Pipe laying shall proceed upgrade with the spigot ends of bell and spigot pipe pointing in the direction of the flow.

I. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements. Use of a pipe laser between structures is required.

J. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

K. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

L. Install gravity-flow, nonpressure, drainage piping according to the following:
   1. Install piping below frost line.
   2. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
   3. Install piping to the elevations indicated on the Contract Drawings. The Contractor shall notify the Engineer immediately of any discrepancies in elevations prior to pipe installation.

M. Clear interior of piping of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

N. Lubricants shall be used as recommended by the pipe manufacturer.

O. Installations of solvent weld joint pipe, using PVC pipe and fittings shall be installed in accordance with ASTM F 402.

P. When work is not in progress, open ends of pipe and fittings shall be plugged so that no trench water or other material will enter the pipe or fitting.

Q. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints.

R. Pipe cutting:
1. Where required, sections of pipe may be cut to provide shorter sections of pipe necessary for the construction. The cutting of the pipe shall be done in accordance with the pipe manufacturer's recommendations and subject to the approval of the Architect.
2. In general, the pipe material shall be cut by using a saw or milling process, approved by the pipe manufacturer and not by using any impact device, such as a hammer and chisel, to break the pipe. The pipe shall be cut, not broken. The cut end of the pipe shall be square to the axis of the pipe and any rough edges ground smooth.

3.03 PIPE JOINT CONSTRUCTION

A. Where specific joint construction is not indicated, follow piping manufacturer's written instructions.

B. Join gravity-flow, nonpressure, drainage piping according to the following:
1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.
2. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

3.04 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use pipe fittings, as specified on Contract Drawings, in sewer pipes at branches for cleanouts and for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

B. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.05 MANHOLE CONSTRUCTION

A. General
1. Install on compacted gravel base in accordance with Earthwork Section.
2. Manhole steps shall be provided in all manholes. Steps shall be cast into the walls of the structures so as to form a continuous ladder with a distance of 12 inches between steps.

B. Manhole inverts and free drops:
1. The invert channels shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly.
2. The invert channels shall be formed directly in the concrete of the manhole base, or shall be built up with up brick and mortar.
3. The floor of the manhole outside the channels shall be smooth and shall slope toward the channels not less than 1 inch per foot nor more than 2 inches per foot.

C. Pipe connections:
1. Connect to precast bases using manufactured connections.
2. Seal connections to concrete block bases with flexible rubber connectors with stainless steel pipe clamps and expansion bands.

D. Jointing:
1. Brick shall be laid radially or in stretcher courses with every sixth course laid as a stretcher course or radially.
2. Mortar joints shall be completely filled and shall be smooth and free from surplus mortar on the inside of the manhole.
3. Installation of O-ring rubber gaskets between precast concrete sections shall be in accordance with the manufacturer's recommendations.
4. Joint between precast concrete sections shall be full-bedded in compressible filler and shall be smoothed to a uniform surface on both the interior and exterior of the manhole.

E. Parging:
1. Riser sections constructed of brick or concrete block shall be parged on the exterior with a layer of cement mortar parging, 1/2-inch minimum thickness.

F. Frames and covers:
1. Frames shall be set on cement mortared brick courses to required grade and concentric with the opening.
   a. Concrete barrel block is not acceptable for grade adjustment.
2. All voids beneath the bottom flange and in the brick courses shall be filled to make watertight. A ring of cement mortar 1 inch thick, minimum, shall be placed around the outside of the bottom flange, extending to the top edge of the frame, all around the frame circumference.
3. Brick shall be parged on the exterior with a layer of cement mortar parging, 1/2-inch minimum thickness.

3.06 CONCRETE ENCASEMENT PLACEMENT

A. Place concrete on compacted material in trench bottom. Vertical sides of trench may be used instead of formwork provided that material is undisturbed, and surface is as uniform and smooth as is practicable.

B. Concrete shall cure for a minimum of 24 hours before being backfilled.

3.07 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains as shown on the Contract Drawings. Use a Mueller adaptor or approved equivalent to connect SDR-35 pipe to sanitary waste vent piping.

B. Make connections to existing piping.
1. Use properly sized shielded coupling. Connection shall be an approved Town of Bloomfield WPCA typical connection.

3.08 BACKFILLING AND COMPACTION

A. Special backfilling and compaction requirements.
1. As soon as possible after the joint is made sufficient, the pipe shall be backfilled and compacted with sand fill to a depth of 6 inches above top of pipe.
2. Completion of backfilling and compaction shall not take place until testing has been completed and accepted.

3.09 FIELD QUALITY CONTROL

A. General:
   1. Perform field tests on sanitary sewers, at no additional cost to the Owner. Provide all labor, equipment and incidentals required for testing.
   2. Perform additional field tests on sanitary sewers, at no additional cost to the Owner, as may be required by the Town, authorities or agencies to whose requirements the work is to be in accordance with.
      a. It is the Contractor's responsibility to ascertain the extent of additional testing required by the Town, authorities, or agencies involved in this work.
      b. If there is disagreement between standards as required by the Town, authorities or agencies and the Contract Documents, the stricter shall govern.
   3. Begin testing within 10 working days after completion of sanitary sewer work.
      a. If a section of sanitary sewer line is not to be installed until later in the construction schedule, the sections of sanitary sewer line installed shall be tested within 10 working days after their completion, with the other sections tested within 10 working days after their installation.
   4. The Contractor shall give a minimum of 48 hours' notice before starting field testing to all interested parties.
   5. Should the sanitary sewer pipe, as laid, fail to meet the requirements specified, the Contractor shall perform the necessary work, including re-testing, at no additional cost to the Owner, to meet the requirements specified.

B. Joints: Inspect joints.

C. Alignment test:
   1. The Contractor shall check each straight run of sanitary sewer pipe for gross deficiencies by holding a light in a manhole or the last section of pipe laid before connection is made; it shall show a practically full circle of light through the run of pipe when viewed from the adjoining end of line.

D. Air test:
   1. Test in accordance with the Uni-Bell PVC Pipe Association UNI-B-6 Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe.
   2. Use low pressure compressed air at 4 psig pressure greater than the groundwater back-pressure. Measure the time for pressure loss of 0.5 psig. The maximum acceptable rate of air loss is 0.0015 cfm per square foot of internal pipe surface.

E. Manhole Vacuum Test:
   1. Draw a vacuum in the manhole of 10 inches of Mercury (Hg) and disconnect vacuum pump.
   2. Test duration = 1 minute
   3. Maximum pressure increase: 1 inch of mercury (vacuum drop from 10 to 9 inches of mercury). If the pressure change exceeds 1-inch of mercury in 2 minutes, repair the manhole and retest.

F. 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 report for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between structures

b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size 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 inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

G. Before testing sanitary sewer lines, the Contractor shall thoroughly clean sanitary sewers by flushing with water or other means to remove debris. Minimum water flow shall be 50 gallons per minute.
1. Each run of pipe between manholes shall be flushed individually and the debris caught in and removed from the lower manhole.
2. Water shall be introduced at the manhole, in the run of pipe being cleaned, with the highest invert elevation.
3. The Contractor shall make a visual inspection of sanitary sewer lines and manholes after flushing to verify that all debris has been removed. Repeat flushing if necessary, at no additional cost to Owner.
4. Water for testing must be prearranged with Town of Bloomfield. Any fees will be the responsibility of the Contractor.

H. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
a. Allowable leakage is maximum of 50 gal./inch of nominal pipe size per mile of pipe, during 24-hour period
b. Close openings in system and fill with water
c. Purge air and refill with water
d. Disconnect water supply
e. Test and inspect joints for leaks
f. Option: Test ductile-iron piping according to AWWA C600, "Hydrostatic Testing" Section. Use test pressure of at least 10 psig
6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
a. Option: Test plastic gravity sewer piping according to ASTM F 1417
b. Option: Test concrete gravity sewer piping according to ASTM C 924
7. Vacuum Test: Vacuum test sanitary manholes in accordance with ASTM C1244.

I. Leaks and loss in test pressure constitute defects that must be repaired.

J. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

A. Clear interior of piping and structures of dirt and other superfluous material as work progresses.

B. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of workday or when work stops.

3.11 AS-BUILT DRAWINGS

A. Provide detailed as-built drawings showing inverts for pipe runs, bends, connections, manholes, cleanouts, type of connections, and any existing utilities encountered during installation.

END OF SECTION 33 31 00

SECTION 334000 – STORM DRAINAGE

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.02 TRENCH EXCAVATING AND BACKFILLING

A. Quality Assurance

1. Testing of compacted fill materials shall be performed by an independent testing laboratory.

2. When work of this section or portions of work are completed, the contractor notifies their testing laboratory to perform density tests. Do not proceed with additional portions of work until results have been verified.

3. If, during progress of work, tests indicate that compacted materials do not meet specified requirements, notify the Inspector as to direction to proceed. If required by the Inspector, remove the defective work, replace and retest.

4. Ensure compacted fills are tested before proceeding with placement of surface materials.

5. Examine existing and finish grades as shown on grading plan and excavation and fill as indicated on plans and elevations. Protect and maintain site boundaries and project limits during construction. If disturbed, destroyed or exceeded, repair as directed.

B. Protection

1. Protect bench marks, monuments, other reference points, existing structures, roads, sidewalks, paving, curbs, overhead and underground utilities against damage from equipment and vehicular or foot traffic.

2. Protect excavations by shoring, bracing, sheet piling, underpinning, or other methods as required to sustain excavated areas.

3. Protect the bottom of excavations and soil around and beneath utilities from frost.

4. Grade around excavation to prevent surface water run-off into excavated area.

C. Materials

1. Fill: Usable material excavated within the limits of work conforming to Article M.02.06 Grading "A" of Form 818.

2. Pipe Bedding: Conform to Article M.08.01-21 of Form 818.

3. Sand: Conform to Article M.03.01-2 of Form 818.

4. Crushed Stone: Conform to Article M.01.01 of Form 818 for the size indicated on the plans.

5. Bank Run Gravel: Conform to Article M.02.06 Grading "A" of Form 818.

6. Processed Gravel: Conform to Article M.02.06 Grading "C" of Form 818.

E. Removing Existing Pavement Surfaces

1. No excavation shall be made until existing paved surfaces have been neatly saw-cut. Pavement, which is weakened or destroyed beyond the limits indicated, shall be re-cut and trimmed.

2. All pavement removal within state highways shall be in strict accordance with all requirements of the DOT and Town Department of Public Works. Conditions of permits for excavation within established rights-of-way shall be strictly observed and the Contractor shall assume full responsibility for violations thereof.

F. Earth Excavation

1. Excavation shall be in open cut with sheeting provided in areas shown on the plans or as required.

2. When materials encountered are not suitable for the utility or when it is found desirable or necessary to go to additional depth, the excavation shall be carried to an additional depth or as specified by the engineer. Contractor shall notify the engineer of any unsuitable soils.

G. Site Contamination

1. The suspicion of, or unanticipated discovery of, contaminated ground during the excavation, or other work task under this contract, shall be reported immediately to the Construction Manager or Owner. The Contractor, at all times, shall exercise caution to protect workmen, observers, and residents from harm. The Contractor shall provide all reasonable and necessary assistance to ascertain the nature and source of ground contamination.

H. Protection of Work

1. Provide safe working conditions for the protection of people, materials, and equipment involved in the work, and to protect the public, adjacent structures, utilities, poles, pipe lines, duct, conduit, streets and other public or private property from cave-ins, slides, settlement or other damage.

2. Contractor shall assume full responsibility for compliance with all local codes or State and Federal laws which pertain to safe working conditions for the protection of men, materials, and equipment during excavation.

3. Existing pipes, poles, wires, fences, curbings, property-line markers, and other structures, which must be preserved in place without being temporarily or permanently relocated, shall be carefully supported and protected from injury. Should such items be damaged, they shall be restored by the Contractor, without compensation, to at least as good a condition as that in which they were found immediately before the work was begun.

4. Cooperate closely with all utility companies involved and to ascertain the exact locations of all utilities prior to excavation. Existing utilities will be protected from damage during construction, and if damaged, shall be repaired. Note that it is generally not the policy of the local utilities to mark locations of services on private property. Therefore, it is the responsibility of the Contractor to locate utilities on the site.

5. Power-driven excavating machinery shall be handled with care to prevent damage to trees, particularly to overhanging branches. Branches shall not be cut off.

6. Dig up, handle, protect and properly reset signs, posts, guard rails and the like along the line of or adjacent to the work.

7. Utility poles or other structures in close proximity to trench excavations must be tied back, braced or otherwise temporarily supported to the satisfaction of the utility company. Costs for providing such support, or damages resulting from inadequate or insufficient support, shall be the Contractor's sole responsibility and no separate compensation will be made.

8. Damage to electric poles, or their attachments, underground duct lines, manholes, conduits or their components caused by the Contractor shall be repaired by the controlling utility agency.

I. Care and Restoration of Property

1. Do not use or operate tractors, bulldozers, or other power-operated crawler equipment on paved surfaces; the treads or wheels of which are so shaped as to cut or otherwise injure such surfaces without providing proper protection for the pavement.

2. Replace in kind, all granite, concrete or bituminous curbing removed. Granite or pre-cast concrete curbing shall be set plumb and true to the lines and grades established and shall be backed up with materials equal to those removed. Existing cast-in-place or bituminous curbing which is damaged or destroyed, or pre-cast concrete or granite curbing which is damaged, and is not scheduled for removal, shall be replaced with new curbing equal to that removed.

3. All surfaces, which have been injured by the Contractor’s operations, shall be restored to a condition at least equal to that in which they were found immediately before work was begun. Suitable materials and methods shall be used for such restoration.

4. The restoration of existing property or structures shall be done as promptly as practicable and shall not be left until the end of the construction period.

J. Disposal of Surplus and Unsuitable Excavated Materials

1. Dispose of material off-site in a legal manner.

K. Dust Control

1. Conduct operations and maintain the area of activities, including sweeping and sprinkling of area as necessary, so as to minimize the creation and dispersion of dust. If it is necessary to use calcium chloride for more effective dust control, the Contractor shall furnish and spread the material as directed.

L. Sheeting and Shoring

1. Provide sheeting and shoring as required.

M. Dewatering

1. Contractor shall at all times keep the excavation free from water. The water shall be disposed of by the Contractor in accordance with the General Conditions and applicable laws and regulations.

2. Contractor shall provide all necessary pumps, dams, drains, ditches, flumes, well points, and other means for excluding and removing water from trench excavations, and for preventing the slopes from sliding or caving in. Contractor shall satisfactorily remove all water, which interferes with the work. The Contractor shall sufficiently dewater trenches to completely dry out and solidify the foundation below the bottom of the pipe to whatever depth is necessary to provide a firm, solid, completely dry foundation on which to lay the pipe.

3. Sediment laden water shall not be pumped off-site. It shall be filtered through a sediment fence, sediment basin, “dirt bag” or other approved filtration system prior to being discharged.

N. Backfilling

1. As the various pipes or utilities are installed, refill the space outside and around the pipe walls with approved materials to the depths, and widths, and as shown on the plans. All forms, bracing, and lumber shall be removed before backfilling.

2. Frozen material shall not be placed in the backfill nor shall backfill be placed upon frozen material. Previously frozen material shall be removed or shall be otherwise treated as required before new backfill is placed.

3. Backfill shall be placed in lifts no greater than 6” and shall be well tamped or otherwise thoroughly compacted to 95 percent of maximum dry density as determined by *ASTM* test D1157, Method D, by mechanical compactors and/or vibrators before additional lifts are placed.

4. Backfill shall be placed and compacted in a manner so as not to damage any waterproofing materials applied to the outside of any structure. Any damage caused to waterproofing shall be repaired at the Contractor's expense.

5. If necessary to ensure proper compaction by tamping or rolling, the material shall first be wet by sprinkling. However, no compaction by tamping or rolling shall be done when the

material is too wet either from rain or too great an application of water to be compacted properly. At such times, the work will be suspended until the previously placed and new materials have dried out sufficiently to permit proper compacting, or such other precautions shall be taken as may be necessary to obtain proper compaction.

6. Care shall be taken that stones and lumps do not become nested and that all voids between stones shall be completely filled with fine material.

7. All voids left by the removal of sheeting shall be completely backfilled with suitable materials and thoroughly compacted.

1.03 TRENCH ROCK EXCAVATION

A. Explosives

1. If explosives are used, obtain all necessary permits and licenses.

2. Explosives must be carefully transported, stored, handled and used. Keep on the job only such quantities of explosives as may be needed for the work underway and only during such time as they are being used. Explosives shall be stored in a secure manner in locked containers and separate from all tools. Caps and detonators shall be stored separately from other explosives. When the need for explosives is ended, all such materials remaining on the job shall be promptly removed from the site. Care must be taken that no explosives, caps or detonators are stolen or get into the hands of unauthorized persons or left unguarded.

B. Blasting Log

1. An accurate blasting log must be maintained. The Contractor shall record in the log, for each shot; the location, number of holes, depth, spacing, amount of explosive per hole; number, type and delay interval of blasting caps used; horizontal distance to existing structures and utilities (sewer, water, gas, etc.); and the date and exact time of the blast.

2. The log shall include a sketch for each shot showing the location of every blasting cap and its delay period and comments regarding any property damage or unusual results.

C. Blasting

1. A pre-blast survey is required for all new and existing structures, which could be affected by blasting.

2. An on-site seismologist shall be employed during all blasting operations.

3. Give at least 24 hours notice and a schedule of blasting operations to the operating official, company or companies leasing, owning or responsible for pipes, conduits, poles, wires, or any other public or private utilities which may be endangered by the blasting.

4. When blasting is necessary, it shall be done in accordance with all Town Ordinances, State Statutes and other pertinent regulations and under the direction of the Fire Marshal. Such ordinances, regulations and orders shall not, however, relieve the Contractor of any responsibility for damages caused by him or by his employees.

5. Prior to the firing of blasts, all persons in the vicinity shall be given ample warning. All blasts shall be well covered, and provisions shall be made to protect all pipes, conduits, sewers and structures, and all persons or property along and adjacent to the site of the work.

6. If damage is incurred by adjacent properties, blasting shall cease until the extent of the damage has been documented.

7. If damage occurs to any portion of structures or to the materials surrounding or supporting the same through blasting shall rebuild or repair the structures and replace the material surrounding or supporting the same.

8. If any damage occurs to any existing utility through blasting, the controlling utility company may do the repairs.

D. Shattered Trench Rock

1. If trench rock below normal depth is shattered due to operations of the Contractor, and the Engineer considers such shattered trench rock to be unfit, the shattered rock shall be removed and the excavation shall be backfilled with fill as required.

E. Excess Trench Rock Excavation

1. If trench rock is excavated beyond the limits indicated on the drawings, the excess excavation, whether resulting from overbreakage or other causes shall be backfilled using bank run gravel.

F. Splitting

1. Drilling and splitting trench rock by hydraulic means (or some other approved method) to remove it or to make it smaller, for more manageable pieces to be removed by machinery is allowable.

G. Disposal

1. Excavated trench rock may be used for fill in embankment areas as directed.

2. Excess excavated trench rock shall be disposed of off-site in a legal manner.

1.04 CATCH BASINS AND DRAINAGE MANHOLES

A. Materials

1. Catch Basin and Manhole blocks and pre-cast units: Conform to Article M08.02 of Form 818.

2. Frames and grates: Conform to Town standards. Frames and grates shall be galvanized, Type A.

3. Crushed Stone: Conform to Article M.01.01 of Form 818 for the size indicated on the plans.

4. Mortar: Conform to Article M.11.04 of Form 818.

B. Construction Methods

1. Excavate and backfill in accordance with Section 312000.

2. Place crushed stone base to the size and thickness as shown on the plans.

3. Set pre-cast sump or pour concrete slab to the proper elevation.

4. All concrete block and pre-cast units shall be laid in full mortar beds.

5. Inside joints of concrete blocks are to be pointed flush.

6. Inlet and outlet pipes shall extend through the walls for a sufficient distance beyond the outside surface to allow for satisfactory connections. The concrete and mortar shall be constructed around them neatly to prevent leakage along their outer surfaces.

7. Pipe shall be cut flush with the inside face of the wall, or as shown on the plans.

8. Set top to "top of frame" grade as shown on plans.

C. Cleaning Catch Basins

1. During installation, use every precaution to keep drainage pipes free of foreign materials.

2. After all site work is completed, including spreading of topsoil and seeding, clean debris from all catch basins.

1.05 DRAINAGE PIPE

A. Materials

1. Reinforced concrete pipe (RCP): Conform to Article M.08.01 (6) of Form 818. Pipe shall be Class IV unless otherwise specified.

2. High Density Polyethylene Pipe (HDPE): Conform to *AASHTO* M294, (Type “S’).

B. Construction Methods

1. Excavate and Backfill in accordance with Section 4.4.1.

2. Pipe bedding shall be rounded to accommodate the bottom quadrant of the pipe. The interior of the pipe shall be clean when it is lowered into the trench.

3. Pipe laying shall begin at the downstream end. No pipe shall be placed unless a suitable outlet is provided. Batter boards shall be placed at intervals of not over 25’ or other suitable control shall be used to eliminate sag in the line during installation.

4. Bell ends shall be placed upstream with the spigot ends fully inserted into the adjacent bell end.

5. Any piping, which is not in true alignment, shows settlement or is otherwise unsatisfactorily bedded, shall be taken up and re-laid.

C. Cleaning Piping

1. During installation, use every precaution to keep pipes free of foreign materials.

2. After all site work is completed, including spreading of topsoil and seeding, clean debris from all lines.

1.06 UNDERDRAINS

A. Materials

1. Slotted Reinforced Concrete Pipe (RCP): Conform to Article M.08.01 (10) of Form 818. Pipe shall be Class IV unless otherwise specified.

2. Perforated High Density Polyethylene Pipe (HDPE): Conform to *AASHTO* M294, (Type "S').

3. Crushed Stone: Conform to Article M.08.03 of Form 818 for the size indicated on the plan.

4. Geotextile fabric: Conform to Article M.08.01 (26) of Form 818.

B. Construction Methods

1. Excavate and Backfill in accordance with Section 4.4.1.

2. A geotextile filter fabric shall be used too completely encapsulate the underdrain system.

3. The dimensions of the trench shall be as shown on the plans or as directed. Where the bottom of the trench is unstable, sufficient unstable material shall be removed and replaced with crushed stone or gravel to stabilize the trench bottom.

4. Place fabric and 6" of crushed stone under the pipe. Place pipe with openings down.

5. Pipe laying shall begin at the downstream end. No pipe shall be placed unless a suitable outlet is provided. Batter boards shall be placed at intervals of not over 25' or other suitable control shall be used to eliminate sag in the line during installation.

6. Bell ends shall be placed upstream with the spigot ends fully inserted into the adjacent bell ends.

7. Any piping, which is not in true alignment, shows settlement or is otherwise unsatisfactorily bedded, shall be taken up and re-laid.

8. Backfill pipe to 12" above the top of pipe with crushed stone. Lay filter fabric over stone to completely enclose system. Lap the filter fabric a minimum of 6".

C. Cleaning Piping

1. During installation, use every precaution to keep pipes free of foreign materials.

2. After all site work is completed, including spreading of topsoil and seeding, clean debris from all lines.

1.07 FLARED ENDS

A. Material

1. Reinforced Concrete Flared Ends: Conform to Article M.08.01-22 of Form 818.

2. HDPE flared ends shall not be used.

3. Processed Gravel; Conform to Article M.02.06 Grading “C” of Form 818.

4. Mortar: Conform to Article M.11.04 of Form 818.

B. Installation

1. Flared ends shall be placed on a prepared gravel base to the grades and alignment shown on the plans.

2. When using HDPE pipe, reinforced concrete flared ends shall still be used. The HDPE pipe shall be mortared into the concrete flared end.

1.08 RIPRAP

A. Material

1. Riprap: Conform to Article M.12.02 of Form 818 for the size shown on the plan.

2. Processed Gravel: Conform to Article M.02.06 Grading “C” of Form 818.

3. Geotextile: Conform to Article M.08.01-26 of Form 818.

B. Preparation

1. The area to be protected by riprap shall be accurately shaped prior to placing any geotextile, processed gravel, or riprap. Processed gravel and the geotextile shall be placed on the prepared area and compacted to the depth, lines and grades indicated on the plans.

C. Installation

1. The riprap shall be placed to its full course thickness in one operation in such a manner as to produce a reasonably well graded mass of rock without causing displacement of the underlying material. Placing the material by methods likely to cause segregation of the various stone sizes will not be permitted.

2. The finished surface shall be free from pockets of small stones and clusters of large stones. Rearranging of individual stones by mechanical or hand methods will be required to the extent necessary to obtain a reasonably well graded distribution of the specified stone size.

1.09 CONCRETE HEADWALLS AND ENDWALLS

A. Material

1. Concrete:

a. Cement shall meet *ASTM* C150 or C595 Type II.

b. Mixing water shall be clean and free from injurious amounts of oils, acids, alkalis, organic materials or other deleterious substances in accordance with *ACI* 318.

c. Air-entraining admixture shall conform to *ASTM* C260.

d. Any other admixtures shall only be used if approved by the Engineer.

e. Concrete shall have the following properties:

i. Materials shall be proportioned to produce concrete with a minimum compressive strength of 3,500 psi at 28 days.

ii. The air content shall be 5% by volume with a tolerance of $\pm$ 2%.

iii. Maximum size of aggregate shall be 3/4".

iv. Minimum cement content shall be 520 pounds per cubic yard.

v. Concrete shall be delivered at the minimum slump necessary for efficient mixing, placing and finishing. The maximum slump shall be 4” with a tolerance of $\pm$ 1”.

vi. The concrete shall be batched and mixed in accordance with *ASTM* C94.

2. Reinforcing

a. Reinforcing steel shall be deformed reinforcing bars meeting *ASTM A 615* and have a minimum yield strength of 60,000 psi.

B. Forming, placing steel, pouring, and finishing

1. All form work, forming, steel placement, pouring, curing and finishing shall be in accordance with *ACI 318-89*. Except that all exposed edges shall have a 1” chamfer and all exposed surfaces shall have a hand rubbed finish.

PART 2 - PRODUCTS

1. All products shall conform to Town standards and Form 818.

PART 3 - EXECUTION

1. All construction methods shall conform to Town standards and Form 818.

END OF SECTION 33 40 00

TECHNOLOGY, PHYSICAL SECURITY, AND AUDIO-VISUAL NARRATIVE

INTRODUCTION

The Technology Systems described within this section shall include Tele-Data-Video-Security Communication cabling infrastructure, Telephones, Audio Visual Systems, Clocks, Public Address, Physical Security Systems, Network Electronics, UPS's, and Wi-Fi devices, which are intended to be designed and specified into the Prosser Bloomfield Public Library project.

Installation of entirely new technology systems shall be required as part of this project and as described within the following.

COMMUNICATION CABLING INFRASTRUCTURE

New Ethernet cabling to support the Phone, Data, Audio-Video, and Security systems is required.

There shall be one centrally located Main Equipment Room (MER) and one Telecommunication Rooms (TR) utilized to distribute Ethernet cabling throughout the library.

The new Ethernet cabling infrastructure shall accommodate all current and future technologies via TCP/IP. All workstation and equipment requiring Ethernet cabling shall terminate within the MER or the TR's. The TR shall connect directly to the Main Equipment Room (MER) via the fiber optic and copper backbone cabling described below.

All Ethernet horizontal distribution cabling shall consist of Category 6 (250 Mhz minimum per pair) UTP, 24 AWG copper, plenum rated cabling for all Ethernet device connectivity. All cabling shall be terminated onto RJ45 style jacks at each end device and 19" rack mounted RJ45 style, Category 6 rated patch panels within the MER and all TRs. This horizontal communication network cabling shall deliver a minimum of 1Gbps to each endpoint and shall support all Internet, Voice, Data, Security Systems, and A/V content via TCP/IP. All Ethernet cabling installation and testing requirements shall conform to TIA-568-C.2 and BICSI recommendations.

Ethernet cabling to accommodate the Wireless Access Points (WAPs) shall consist of Category 6A rated cabling (500 Mhz minimum per pair) UTP, 24 AWG copper, plenum rated cabling. Access Points shall be located throughout the interior and exterior of the facility achieve satisfactory coverage. Exterior Wi-Fi coverage shall be defined during the needs assessment and is likely to be required. The WAP ethernet cabling shall be installed, terminated, and tested as part of the base construction for this project.

The Data Backbone distribution cabling for the network connectivity between the MER and each TR shall be 50/125um, OM4, multimode, indoor, plenum, armored fiber optic cable. Twelve strands of fiber shall be specified between the MER to the TR in a star topology. This fiber optic backbone shall support a minimum of 410Gb between the MER and the TR. All fiber optic cabling installation and testing requirements shall conform to TIA-568.3-D and BICSI recommendations

The Analog Backbone distribution cabling for connectivity between the MER and the TR shall be 25 pairs of Category 5E (100 Mhz minimum per pair), UTP, 24 AWG copper, plenum rated cable.

Ethernet cabling locations and quantities per workstation shall be defined by the Bloomfield Public Libraries (BPL) as required during the need's assessment.

NETWORK ELECTRONICS

New network electronics are required for this facility. The network electronics manufacturer shall be HP/Aruba as mandated by BPL.

These network switches shall support the data, voice, Wi-Fi, access controls, video surveillance, and all current and foreseeable audio-video application networks. Minimally, these devices shall be 10/100/1000 gigabit, Layer 3 protocol technology that will accommodate multiple VLANS, multicasting and routing capabilities.

Network switches shall be located within the MER and TR and shall be mounted onto the 19" racks.

Uninterrupted Power Supplies (UPS) shall be sized accordingly to support these network electronics. The UPSs shall allow adequate time for the Generator backup power to engage (should there be one at this facility) or allow proper shut-down of the network switches and servers within the data rooms. These UPSs are not planned to support these electronics for more than approximately 8-10 minutes.

TELEPHONE SYSTEM

All phone handset locations shall receive new Category 6 plenum rated cabling as described in a previous section. The VoIP telephone manufacturer shall be NEC as mandated by BPL.

New VoIP handsets and a network switches are required for this Library. Minimally, this system shall have a back-up emergency power for the network switches, which support the VoIP handsets with a minimum of 24 hours.

New phone handsets shall be located within all administration areas, conference rooms, mechanical and data rooms, larger storage rooms, work areas and within gathering spaces as defined by BPL during the needs assessment. All handsets shall be capable of sending and receiving outside phone calls as permitted by BPL. The voice system shall interface with the Public Address (PA) system to allow for secured access to the controls of the PA system via any handset on the VoIP system.

WIFI

New Wireless Access Points (WAPs) are required for this Library. Wireless Access Points shall provide even wireless coverage throughout the interior and exterior of the building. The Wireless Access Point manufacturer shall be HP/Aruba as mandated by BPL.

PEOPLE COUNTERS

New People Counters are required for this Library. People counters shall be provided at each door accessible by the public.

WEATHER STATION

A new exterior mounted weather station is required for this Library. The weather station shall be capable of sending weather data to on-site and off-site terminals.

AUDIO VISUAL SYSTEMS

COMMUNITY ROOM

Shall consist of the following:

- Multiple digital displays
- Electric Screen and Large Format Projector
- Performance capable sound system including speakers, amplifiers, and digital signal processors
- Wireless and hardwired microphones
- Capability to stream wirelessly within the room
- Capability to facilitate video conferencing
- Control panels to control system functionality
- Mixing console to control microphone live mixing
- AV input modules for Bring Your Own Device connectivity
- AV cabinet to house all equipment
- Cameras to be utilized for lecture capture, video conferencing solutions, and event streaming

CONFERENCE ROOM

Shall consist of the following:

- Digital display
- Cameras to be utilized for video conferencing solutions
- Speakers, amplifier, and digital signal processor
- Hardwired microphones for video conferencing
- Capability to stream wirelessly within the room
- Capability to facilitate room hosted video conferencing
- Control panels to control system functionality
- Bring Your Own Device (BYOD) connectivity solutions
- AV rack to house all equipment

COLLABORATIVE STUDY ROOMS

Shall consist of the following:

- Digital display
- Bring Your Own Device (BYOD) connectivity solutions
- Speakers, amplifier, and digital signal processor

- Capability to stream wirelessly within the room
- Control panels to control system functionality

TRAINING ROOM

Shall consist of the following:

- Digital Display
- Appropriately sized sound system including speakers, amplifiers, and digital signal processors
- Wireless and hardwired microphones
- Capability to stream wirelessly within the room
- Capability to facilitate video conferencing
- Control panels to control system functionality
- AV input modules for Bring Your Own Device connectivity
- Cameras to be utilized for lecture capture, video conferencing solutions, and event streaming

TEEN AREA FOR PROGRAMS AND GAMING

Shall consist of the following:

- Digital displays
- Bring Your Own Device (BYOD) connectivity solutions
- Speakers, amplifier, and digital signal processor
- Capability to stream wirelessly within the room
- Control panels to control system functionality
- Digital gaming consoles

Display Signage Monitors

There shall be LCD professional monitors throughout the facility as directed by BPL during the needs assessment.

These monitors shall include a signage application as defined by the BPL as required during the needs assessment to display content onto these monitors. Content may include menus, ticket prices, calendar of events, or general announcements.

PUBLIC ADDRESS SYSTEM

A new addressable public-address system shall be installed as part of this project. Speakers shall be located in all interior and exterior spaces to accomplish proper audible coverage for both standard and emergency announcements.

All public-address speakers installed shall be cabled as an independent, home run back to the appropriate MER and/or TR. Each office shall receive a PA volume control attenuator.The PA zoning shall be created via programming of the system.

The system shall accommodate routine communications, All-Call and automated emergency broadcasting during an emergency event. The PA system shall be completely integrated with the phone system, so that any phone handset can utilize the PA system for communication to any and all locations with PA speakers installed.

PHYSICAL SECURITY SYSTEMS

Physical Security Systems are specifically referring to Intrusion Detection Systems, Access Control Systems, and Video Surveillance Systems.

Intrusion Detection System

A new intrusion system shall include a combination of passive infrared detector (PIR motion detectors) and door position switches (door-contacts) installed at each exterior door and roof latches to notify the monitoring service when a door is breached after hours when the alarm is set. The controller keypad(s) shall be located within the facility as defined by BPL and may be included at several locations as required. All devices shall be wired back to the security panels, which shall be located within the allocated MER and/or TR's. Additional locations shall be defined by BPL as required during the needs assessment and may include monitoring access to the stairs, offices and other sensitive areas with high cost and valuable equipment.

This intrusion system shall include duress buttons that shall notify the central monitoring company in the event of an emergency, 24/7/367. There shall be panic/duress buttons placed throughout the facility as required by BPL.

This system shall interface with the fire alarm, public address system, telecom system for dial-out, and the other security systems as mandated by local codes and BPL.

The system shall be designed to account for separate zones to limit use of parts of the building during community use of the spaces. Keypads shall be allocated throughout each zone to allow for easy arm and disarm of the system.

Access Control System

The Access Control shall be a LENEL/S2 system, as defined by BPL. Minimally, this system shall consist of credential readers on all exterior doors with access to the main building, request to exit devices at all exterior doors used for ingress and door position switches (door-contacts) which shall allow permitted entry into the library during hours described by BPL, along with documentation report features. This system shall be integrated with the fire alarm and all other security systems, particularly the Video Surveillance, to allow for efficient research of recorded reports and events.

Access Controlled doors shall be installed on exterior and potentially interior doors used to separate zones between spaces.

This system shall include a building Lock-Down button, which shall "lock-down" all exterior doors during an

emergency. The programming of this Lock-Down feature shall be described by the BPL and first responders' assessment. Configuration may include:

- Connectivity to Public Address system for announcements
- Connectivity to Police Station for alarm notification or immediate viewing of video
- Connectivity to message system for notification to administration or other facilities within the city
- Connectivity to digital display systems to visually broadcast emergency announcements

Video Surveillance System

The video surveillance system shall be Milestone and shall include AXIS IP, 3 to 5-megapixel or better, IR enabled, varifocal lens cameras within interior and exterior locations, as mandated by BPL.

The video surveillance system shall include multi-sensor 12 to 20-megapixel cameras for general coverage of parking lots, fields, and surrounding exterior areas.

This Video Management system shall integrate with the Access Control system to allow for efficient research of recorded reports and events.

The intent of this design anticipates the minimal inclusion of the following:

Interior cameras shall be installed at the following locations:

- Each door exiting the library to obtain facial descriptions with high-resolution images and video of people exiting the facility. These camera heights will be at approximately 7' AFF and/or ceiling mounted.
- Each vestibule
- Each lobby
- Each corridor at each end of the corridor. If the corridor is longer than 150' long the corridor shall receive QTY (4) cameras.
- Each stairwell landing
- Interior spaces as required by BPL

Exterior cameras

- Exterior cameras shall be installed at each door entry to obtain facial descriptions with high-resolution images and video of people entering the facility. These camera locations will be at approximately 7'-6" AFG.

- Exterior cameras shall be installed on the exterior of the facility to obtain overall coverage of all parking lots, front entrance, visitor doors, play areas, field and general coverage. Exterior mounted locations shall include mounting to the face of the building and on poles throughout the site.
- Exterior cameras shall be installed on the exterior of the facility to obtain focused coverage of each entrance and exit from the street onto the site.

Spot Monitors

- Spot monitors shall be located in areas as defined by the BPL during the needs assessment.
- Monitors shall be 55" LCD professional style displays to accommodate efficient viewing of all the video surveillance cameras. Two monitors with micro-CPUs mounted behind the monitors are anticipated. Controls of the CPU shall be via wireless mouse and keyboards.
- Spot monitors shall also be capable of accessing and monitoring the access control system.
- Spot monitors shall also be included in the security room at the fieldhouse.

Storage Device for the video surveillance system shall accommodate the following calculations:

- Recorded Video Compression Rate: H.264
- Frame Recorded Per Second: Fifteen (15)
- Stored data shall be saved for thirty (30) calendar days
- Interior cameras shall record eighteen (18) hours per day
- Exterior cameras shall record twenty-four (24) hours per day

Bloomfield Public Libraries - Prosser
Bloomfield CT

Budgetary Estimates for Technology, AV, & Security
Date: 10/07/2022

Estimate - V1

SUMMARY OF ESTIMATE

No.	SYSTEM	TOTAL
Technology Systems - Division 27		
1	Structured Cabling	$ 201,000.00
2	Network Electronics	$ 199,500.00
3	Phone System	$ 33,000.00
4	Wireless Access Points	$ 68,000.00
5	People Counters	$ 12,000.00
6	Weather Station	$ 2,500.00
7	Audio Visual Systems	$ 317,000.00
8	Digital Signage Monitors	$ 18,500.00
9	Public Address System	$ 44,000.00
Physical Security Systems - Division 28		
10	Physical Security Systems	$ 237,500.00
	TOTAL	**$ 1,133,000.00**