SPECIFICATIONS

Volume 3 of 3

(CONSTRUCTION DOCUMENTS PHASE)

BPL
BLOOMFIELD PUBLIC LIBRARY
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for

BLOOMFIELD PUBLIC LIBRARY

PROSSER LIBRARY

1 TUNXIS AVENUE
BLOOMFIELD, CT 06002

STATE PUBLIC LIBRARY CONSTRUCTION GRANT 011P-SC-21

February 6, 2023

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APPENDIX

1. **Phase I Environmental Site Assessment – Prosser Library**
   April 2022
2. **Phase II Environmental Site Investigation – Prosser Library**
   June 2022
3. **Phase II Environmental Site Investigation – Former Riley Lumber Property**
   July 2022
4. **Riley Lumber Hazardous Material Survey**
   April 15, 2022
5. **Prosser Library Hazardous Materials Survey**
   April 15, 2022
6. **Fig. 3 – Proposed Phase II ESI**
7. **Geoquest Phase II-III Subsurface Investigation – Prosser Library**
   January 25, 2023

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Department of
Planning & Zoning
TOWN OF BLOOMFIELD
800 BLOOMFIELD AVENUE
BLOOMFIELD, CT 06002-0337
860-769-3515

Memorandum

To: Town Plan and Zoning Commission

From: Justin LaFountain, AICP, CZEO, Interim Director of Building and Land Use

Date: January 24, 2023

Re: Special Permit Site Plan Approval for New Library at 1 Tunxis Ave

---

Background:
The Town of Bloomfield is proposing to construct a new 40,443 s.f. library at the site of the current Prosser Library located at 1 Tunxis Avenue. The application includes a new parking lot at the site of the former Riley's Lumber business located at 6 Mountain Ave which will be connected to the new building by a proposed pedestrian bridge over Wash Brook. The site is located within the Bloomfield Center District. In that district, libraries require a Special Permit approval with a public hearing. The public hearing was opened at the December 15, 2022 meeting of the Town Plan and Zoning Commission.

Additional Reviewing Entities:

The application requires an Inland Wetlands Permit. *The Inland Wetlands and Watercourses Commission* approved the application at their January 10, 2023 special meeting. A copy of the approval letter is included in your packets.

Both the former Riley's property and the Prosser library site lie within the extent of the 100 year *Flood Hazard* area designated for Walsh Brook. An accompanying memo from the Town Engineer addresses the floodplain portion of the application, which can be approved by this Commission.

Prosser Library is located within the Bloomfield Center District, which necessitates referral to the *Design Review Board*. The Library's design team appeared before the Design Review Board at their November 3, and December 1, 2022 meetings. Between the two meetings, the architects for the library made a variety of changes to accommodate the recommendations of the Board. The DRB still expressed some concerns with the design and offered comments for consideration by the applicant. Concerns were primarily related to the proposed pedestrian bridge (including the materials, design including color, appearance from the street and lighting for safety and security purposes), and the entryway plaza (the DRB wished to see the plaza be usable with benches, tables and chairs that are movable, electrical outlets, etc.). The DRB also

noted that they would like to see the light poles be consistent with the other lighting in the Town Center.

Traffic:

The entry to the library from Tunxis Avenue will only be accessible by a right turn. No exit will be permitted from this access point. This is the result of a review by the CT Department of Transportation, which noted that if a left turn into the Library were to be proposed, the traffic lighting would need to be altered at significant cost. As this entry way does not lead to the primary parking area, staff does not believe that this will present any issues.

Parking:

Parking for this project is proposed in two locations: under the library (15 spaces, including five ADA Accessible spaces), and across a pedestrian bridge at the adjoining property currently known as 6 Mountain Avenue (77 additional spaces). This parking arrangement is proposed due to the unique layout of the properties, with a watercourse dividing the proposed library from the parking.

Staff Comments:

Staff recommends that the Commission consider the following items:

1. The light poles should be reviewed by the Commission to determine consistency with surrounding lighting, as recommended by the DRB.
2. The lighting should also be reviewed to ensure that no excessive bleed-off occurs, and that full cut-off lights are utilized.
3. The Commission should ensure that a plan is in place for the accessibility of the pedestrian bridge.
4. The Commission should review the furnishings of the plaza.

Staff also recommends that signage be installed to direct those who require ADA parking into the parking below the building. If the Commission has concerns with any of these items (or any additional items), conditions could be placed on the approval to address them.

Commission Action:
The applicant has addressed all comments from the Town Engineering Division and Planning Division. Should the Commission find that this application meets the criteria for approval, the following is a suggested Motion:

TO APPROVE the Request by Ryszard Szcypek for a Special Permit to construct new public library with associated parking at 1 Tunxis Avenue in the Bloomfield Center District Zone, owner Town of Bloomfield. This approval is subject to conformance with the referenced plans, as may be required to be modified, the representations made on the record, and the following conditions:

Referenced Plans:
"BLOOMFIELD PUBLIC LIBRARY, PROSSER LIBRARY, 1 TUNXIS AVENUE, BLOOMFIELD, CT 06002, STATE PROJECT NUMBER 011P-SC-21" Prepared by TSKP Studio, dated December 7, 2022.

Conditions to be met prior to the signing of plans:

1. The conditions of this approval shall be binding on the applicant, land owners, and their successors and assigns. A copy of this motion shall be placed on the final plans submitted for signing.
2. Signs should be provided on the plans to note that accessible parking is available underneath the building.

Conditions to be met prior to the issuance of permits:

3. Three sets of paper plans with any required changes shall be submitted for the Commission Secretary's signature. The submitted plans shall contain any approval letters and conditions from the Inland Wetlands and Watercourses Commission and the Town Plan and Zoning Commission.
4. A copy of the Special Permit shall be filed on the Land records by the owner of the property.
5. Permanent lot corner monumentation sufficient to establish property lines near any proposed construction activity must be in place prior to commencement of construction.

Conditions which must be met prior to the Issuance of a Certificate of Compliance:

6. Complete as-built plans shall be submitted prior to the issuance of any certificates of zoning compliance. The as-built plan shall also contain a certification by a Professional Engineer that they have inspected the site improvements and that they have been installed in accordance with the approved plans. Any deviations or omissions must be noted.
7. No Certificate of Compliance or other final approval shall be issued until the Zoning Enforcement Officer has signed off on the final work. When minor site work cannot be completed because of weather or other pertinent reason, a conditional approval may be issued for a period not to exceed 180 days, providing satisfactory surety shall be posted with the Town of Bloomfield in an amount sufficient to complete the site work and with surety acceptable to the Planning Director.
8. Any signage must obtain the appropriate approvals.

General Conditions:

9. All pertinent construction shall conform to all applicable Town of Bloomfield standard specifications and details.
10. This approval is for the specific use and structures identified in the application. Any change in the nature of the use or the structures will require new approvals from the Bloomfield Town Plan and Zoning Commission.
11. This approval is also subject to conditions of approval from the Inland Wetlands and Watercourses Agent which are on file separately.
12. This project shall be constructed and maintained in accordance with the referenced plans and representations made for the record. Substantive changes to the plans will require further Commission review and approval. Minor modifications to the approved plans may be allowed in accordance with the regulations, subject to staff review and approval.
13. All work associated with the construction of facilities as approved must be completed by March 25, 2026 or this approval shall be rendered null and void, unless an extension is granted by the Commission.
14. By acceptance of this permit and conditions, the applicant and owner acknowledge the right of Town staff to periodically enter upon the subject property for the purpose of determining compliance with the terms of this approval.

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Engineering Department

TOWN OF BLOOMFIELD
800 BLOOMFIELD AVENUE
BLOOMFIELD, CT 06002-3537
860-769-3524

January 12, 2023

Town of Bloomfield
800 Bloomfield Avenue
Bloomfield, CT 06002

RE: **Wetlands Permit approval – Prosser Library – 1 Tunxis Ave. & 6 Mountain Ave.**

Wetlands File #75-2022-16

To Whom It May Concern,

Please be advised that at their January 9, 2023 Special Meeting the Inland Wetlands and Watercourses Commission, after making a finding of no prudent and feasible alternatives to the proposed regulated activities, voted to approve the above referenced application subject to the attached list of sixteen (16) conditions of approval.

These conditions must be incorporated into revised site plans, and otherwise complied with, before the Wetlands Permit will be issued. Any conditions of approval from the Town Plan and Zoning Commission must also be incorporated into one final set of plans. Please have your engineer or surveyor make the appropriate changes and submit one set of plans for review.

When the final plans are approved by Staff three stamped and sealed sets must be submitted, along with any required fixed-lined mylars, for signing by the Commission. One paper set will be returned with your Wetland Permit. Additional final sets may be submitted if you want more than one set returned.

If you have any questions, please contact the Wetlands Agent, David Peter Castaldi, at 860-769-3526 or by e-mail at *pcastaldi@bloomfieldct.org.*

Sincerely,

Alan Budkofsky

Alan Budkofsky, Chairman
Inland Wetlands and Watercourses Commission
AB/dpc

Attachment – COA's

At a Special Meeting held on January 9, 2023 the Inland Wetlands and Watercourses Commission voted to approve the Permit Application of the Town of Bloomfield for a new Prosser Library at 1 Tunxis Avenue and parking lot at 6 Mountain Avenue, with reference to the site plans revised to December 9, 2022, the applicant's presentations at the Public Hearings and the supporting documentation submitted for this application, and after making a finding of no prudent and feasible alternatives to the proposed regulated activities, subject to the following conditions:

Prior to the issuance of the Wetlands Permit:

1. Final plans, revised for compliance with the final conditions of approval, and all technical review revisions, shall be submitted for review within 60 days of the Wetlands Commission approval, or within 60 days of the date of the Town Plan and Zoning Commission approval, whichever is later, and are subject to the approval of the Wetlands Agent. The final conditions of approval shall be added to the plans verbatim.

2. Three paper copies of the final plan set, and fixed-line mylars of the relevant sheets, signed and sealed, shall be submitted for signing by the Wetlands Commission. The fixed-line mylars shall be filed on the Bloomfield Land Records. Final plans shall also be submitted in digital format compatible with the Town GIS.

Prior to the start of any construction activities including tree clearing:

3. In accordance with Section 11.22 of the Wetlands Regulations the permittee shall file a copy of the Wetlands Permit, including these conditions of approval, on the Bloomfield Land Records.

4. The permittee shall schedule a preconstruction meeting with the Wetlands Agent, developer general contractor, site work contractor and utility companies prior to the start of any construction, tree clearing or ground disturbance.

Conditions to be complied with prior to the approval of a final Certificate of Occupancy or Completion:

5. An as-built site improvement and grading plan, prepared by a licensed Land Surveyor, shall be submitted after all site work has been completed. The as-built plan shall contain a certification by a Professional Engineer that they have inspected the site improvements and that they have been installed in accordance with the approved plans. Any deviations or omissions must be noted.

6. The permittee shall schedule an inspection of the completed project with the Wetlands Agent, at least two weeks prior to the anticipated date of the final Certificate of Occupancy approval to review all parts of the project covered by the Wetlands Permit.

General Conditions to be complied with during and after site development:

7. This permit authorizes certain temporary regulated activities within **wetlands**. The direct impact to wetlands shall be no greater than **1500 square feet** for restoration plantings and the replacement of an existing storm drainage end wall. No regulated activities are proposed within watercourses.

8. This permit authorizes certain regulated activities within the **Upland Review Areas**, 100 feet from wetlands and 200 feet from watercourses. The impacts to the Upland Review Areas shall be no greater than **97,200 square feet (2.23 acres)**.

9. This permit authorizes certain regulated activities within the wetlands and watercourse **Vegetated Buffer Zones**. The impacts to the Vegetated Buffer Zones shall be no greater than **44,900 square feet (1.03 acres)**. Mitigation for impacts to the Vegetated Buffer Zones 50 feet from wetlands, 75 feet from watercourses and 100 feet from Wash Brook shall be provided with enhanced or new buffer vegetation at the limit of clearing, along Wash Brook, and as otherwise specified on these plans.

10. In accordance with Section 11.13 of the Wetlands Regulations, the permittee shall engage and pay for an independent consultant, soil scientist, civil engineer, biologist, wetlands scientist, or other professional, acceptable to the Commission, to report on the progress of the project, and the results of any monitoring and/or inspections as required by the Commission and to provide periodic reports to the Commission regarding sensitive issues such as soil stabilization, siltation or other contamination or pollution of wetlands and watercourses, or the impacts of development or its operation upon completion. Said professional shall, during all phases of construction, perform soil erosion and sediment control measure inspections, and prepare and submit reports on the status of these measures on a weekly basis and within 48 hours of the end of a rain event of one half inch or more in a 24-hour period. Reports are to be submitted to the permittee and site contractor; and submitted in writing to the Wetlands Agent at 800 Bloomfield Avenue, Bloomfield, CT 06002, or by e-mail.

11. All soil stabilization and soil erosion and sediment control measures, details, schedules and notes included on the final plans shall be binding on the permittee and shall be installed and maintained in accordance with the plans or the DEEP 2002 Erosion Control Guidelines if not specified on the plans. Soil stabilization, and erosion and sediment control measures are to be maintained in working condition for the duration of the project.

12. All projects are to comply with the provisions of the 2004 Town of Bloomfield Stormwater Management Plan with regards to pre- and post-construction erosion and sedimentation control measures. A detailed plan and schedule for post-construction stormwater management and erosion control, in accordance with Chapter 9 of the 2004 Connecticut Stormwater Quality Manual, are to be added to the plans.

13. All reports or other correspondence to or from other agencies (DEEP, ACOE, FEMA, etc.) are to be submitted for the record. Any permits or registrations required for the project from the DEEP, ACOE or other state or federal agencies are to be obtained, and copies submitted to the Town of Bloomfield, prior to the start of any construction or land disturbance.

14. In accordance with the Wetlands Regulations Section 11.6 the permit cannot be transferred from the permittee to another party without the approval of the Commission. This permit is to be assigned to the **Town of Bloomfield.**

15. Any modifications to the regulated activities due to the approval or review of the project by the Town Plan and Zoning Commission, the Health District, the DEEP or other state agency, the ACOE or other federal agency shall submitted to the Wetlands Commission for review.

16. Additional information concerning the construction of the proposed footbridge, and its deicing methods, shall be submitted for review and approval at the February 21, 2023 Regular Meeting.

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 2023.

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.

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 2022.

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 2023.

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. Hubbell Incorporated: www.hubbell.com/#sle.
2. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#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. Crestron Electronics, Inc[<>]: www.crestron.com/#sle.
7. Substitutions: See Section 016000 - Product Requirements.
8. 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. Crestron Electronics, Inc[<>]: www.crestron.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. 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. Crestron Electronics, Inc[<>]: www.crestron.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. 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 Approved Draft Standard for Trip Systems for Low-Voltage (1000 V and below) AC and General Purpose (1500 V and below) DC Power Circuit Breakers 2022.

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.

7. Where applicable provide upsized bussing as required per NEC 705 in switchgear for solar power integration

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. Enclosure Space Heaters:
   a. Provide in each switchgear section installed outdoors and in unconditioned indoor spaces.
   b. Size according to manufacturer's recommendations for worst case ambient temperature to prevent condensation.
   c. Heater Control: Thermostat.
   d. Heater Power Source: Provide connection to transformer factory-installed in switchgear or suitable external branch circuit as indicated or as required.
4. 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, with Amendment (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.
6. Where applicable provide upsized bussing as required per NEC 705 in switchboard for solar power integration

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, with Amendment (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 - Basis of Design: Square D.

B. 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.

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 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. Crestron Electronics , Inc; : www.crestron.com/#sle.
5. 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 265000 - LED LIGHTED RAILING

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Fabricate and install metal railings in accordance with the requirements set forth in this section.

1.2 ADDITIONAL WORK INCLUDED IN THIS SECTION

A. Reinforcing for wall rail brackets at dry wall partitions.

B. Field measuring for weld plates, sleeves and insert locations.

C. Field measuring.

D. Anchors or inserts for concrete or other floor surfaces.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Section 03 30 00: Cast-in-Place Concrete

B. Section 32 13 13: Concrete Paving

C. Section 32 14 00 Unit Paving

1.4 STRUCTURAL REQUIREMENTS

A. The structural adequacy of the metal stair design is the responsibility of the designer or professional of record.

B. Railing assembly shall withstand a minimum concentrated load of 200 pounds applied vertically downward or horizontally in any direction, but not simultaneously, at any point on the top rail.

1. Codes may vary in method of application and magnitude of load. Governing code should be checked for specific requirements. Most codes require a 200 pound minimum concentrated load applied in any direction at any point on the top rail.

C. Railing assembly shall withstand a minimum uniform load of 50 pounds per foot applied horizontally or vertically downward, but not simultaneously, on the top rail.

D. Guard intermediate rails, balusters, panel fillers, or posts shall be designed for a uniform load of not less than 50 pounds per square foot applied horizontally over the gross area of the guard of which they are part. Reactions due to this loading need not be added to the loading specified for the main supporting members of the guard.

1.5 QUALITY ASSURANCE

A. Electrician Qualifications: State as required in 1.05.A or state specific qualifications required

B. Fabricator Qualifications: Furnish references listing projects of similar size and scope
   1. If special or unusual capabilities are required they should be set forth here.

C. Installer Qualifications
   1. State as required in 1.05.A or state specific qualifications required.

D. Regulatory Requirements
   1. Components and installation are to be in accordance with state and local code authorities
   2. Components and installation are to follow current ADA and ICC/ANSI A117.1 guidelines.
      a. Determine code regulations that govern this work. Specify requirements and drawings that are necessary to meet governing codes.

E. Certifications
   1. Furnish certification that all components and fittings are furnished by the same manufacturer or approved by the primary component manufacturer.
      a. Furnish certification that components were installed in accordance to the manufacturer's engineering data to meet the specified design loads.
   2. Pre-Installation Meeting
   3. Prior to the beginning of work, conduct a pre-job conference at the job site.
      a. Provide seven calendar days advance written notice ensuring the attendance by competent authorized representatives of the fabricator, building owner's representative, architect and subcontractors whose work interfaces with the work of this section.
   4. Review the specifications to determine any potential problems, changes, scheduling, unique job site conditions, installation requirements and procedures and any other information pertinent to the installation.
   5. Record the results of the conference and furnish copies to all participants.

1.6 REFERENCES

A. Aluminum Association (AA)
   1. ABH-21 Aluminum Brazing Handbook
   2. ASD-1 Aluminum Standards and Data
   3. DAF-45 Designation System for Aluminum Finishes
   4. SAA-46 Standards for Anodized Architectural Aluminum

B. American Architectural Manufacturers Association (AAMA)
   1. AAMA 605.1 Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.
   2. AAMA 606.1 Voluntary Guide Specifications and Inspection Methods of Integral Color Anodic Finishes for Architectural Aluminum.

3. AAMA 607.1 Voluntary Guide Specifications and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum.
4. AAMA 608.1 Voluntary Guide Specifications and Inspection Methods for Electrolytically Deposited Color Anodic Finishes for Architectural Aluminum.

C. American Concrete Institute (ACI)
1. ACI 347 Recommended Practice for Concrete Formwork

D. American National Standards Institute (ANSI)
1. ANSI A21.1 Safety Requirements for Floor and Wall Openings, Railings and Toe Boards.
2. ANSI A58.1 Minimum Design Loads in Buildings and Other Structures.
3. ICC/ANSI A117.1 Accessible and Usable Buildings and Facilities.
4. ANSI A97.1 Safety Performance Specifications and Methods of Test for Safety Glazing Material used in Buildings
    a. ANSI/NAAMM MBG 531 Metal Bar Grating Manual.

E. American Society for Testing and Materials (ASTM)
1. A1264-1 Safety Requirements for Workplace Floor and Wall Openings, Stairs and Railing Systems
2. B 210 Specification for Aluminum and Aluminum Alloy Drawn Seamless Tubes.
3. B 211 Aluminum and Aluminum Alloy Bar, Rod and Wire.
4. B 221 Specification for Aluminum-Alloy Bars, Rods, Wires, Shapes and Tubes
5. B 241 Specification for Aluminum and Aluminum Alloy Seamless Pipe and Seamless Extruded Tube.
6. B 429 Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
7. B 455 Specification for Copper-Zinc-Lead Alloy (Leaded Brass) Extruded Shapes.
8. B 483 Specification for Aluminum and Aluminum-Alloy Drawn Tubes for General Purpose Applications.
9. B 584 Specification for Copper Alloy Sand Castings for General Applications.
10. C 595 Specification for Blended Hydraulic Cements.
11. D 1730 Recommended Practices for Preparation of Aluminum and Aluminum Alloy Surfaces for Painting.
12. E 84 Test Method for Surface Burning Characteristics of Building Materials.
13. E 894 Standard Test Methods for Anchorage of Permanent Metal Railing Systems and Rails for Buildings.
14. E 935 Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
15. E 985 Specification for Permanent Metal Railing Systems and Rails for Buildings.

F. Americans With Disabilities Act Accessibility Guidelines (ADAAG)

G. International Code Council (ICC)
1. International Building Code (IBC)
2. International Residential Code (IRC)

H. National Association of Architectural Metal Manufacturers (NAAMM) and National Ornamental and Miscellaneous Metals Association (NOMMA)

1. Metal Finishes Manual

I. National Association of Architectural Metal Manufacturers (NAAMM)
1. Metal Stair Manual

J. National Fire Protection Association (NFPA)
1. 101 Life Safety Code

1.7 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 013300.
1. Show sections and plans of stairs, dimensions and assembly of components.
a. Railings
b. Handrail
c. Brackets
d. Reinforcements
e. Anchors
f. Welded and bolted connections
2. Show all field connections
3. Provide setting diagrams for installation of anchors, location of pockets, weld plates for attachment of rails to structure, and blocking for attachment of wall rail.
4. Specify adequate back up support for anchoring handrail bracket.
5. Indicate all required field measurements.

B. Indicate component details, materials, finishes, connection and joining methods, and the relationship to adjoining work.

C. Submit manufacturer’s installation instructions under provisions of Section 013300 .

D. Samples:
1. Submit duplicate samples of railing showing style and finish. One approved sample will be returned to contractor.
a. This is only specified if appearance sample is required. Applies to pipe, tubing and extrusions but normally does not apply to carbon steel.
2. Certificates:
a. Furnish manufacturer's certification that materials meet specification requirements.

E. Substitutions:
1. Any changes in specified material must meet requirements of the General Conditions "or equal" clause.
Indicate Section and Paragraph of the General Conditions that sets out "or equal" requirements.
2. Changes in architectural details to fabricator's standard procedures will be allowed when State any alternatives that affect the work and/or bid price of this section, such as a change in material or a change to contractor's standard details.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the job site in good condition and properly protected against damage to finished surfaces.

B. Storage on site:
1. Store material in a location and in a manner to avoid damage. Stacking shall be done in a way, which will prevent bending.
2. Store material in a clean, dry location away from uncured concrete and masonry. Cover with waterproof paper, tarpaulin, or polyethylene sheeting in a manner that will permit circulation of air inside the covering.
3. Keep handling on site to a minimum. Exercise particular care to avoid damage to finishes of material.

PART 2 PRODUCTS

2.1 BASIS OF DESIGN:

A. Railing [pipe] [tube] and components shall be as manufactured or supplied by The Wagner Companies; P.O. Box 423; Butler, WI 53007. Phone: 888-243-6914. Fax: 414-214-0550. Web site: www.wagnercompanies.com. E-mail: info@mailwagner.com.

2.2 MATERIALS AND FINISHES

A. Aluminum:
1. Extruded Pipe: Alloy 6063-T6 meeting ASTM B 221
2. Extruded Bars, Shapes and Mouldings: Alloy 6063-T6 meeting ASTM B 221
3. Castings: Almag 35 meeting ASTM B 26
4. Finish :
a. Painted finish shall be aluminum painted semi-gloss type white color and shall meet the requirements of AAMA 605.1 specification for high performance organic coatings.

2.3 RAILING SYSTEM

A. Material shall conform to 2.02 and be finished in accordance with 2.02

B. Rails: Fabricate rails from aluminum

C. Posts:
1. Fabricate rails from aluminum
2. Mounting: Floor plate Over stubs preset into concrete 6" extension into concrete.
3. Attachment: Attach post to underside of railing by use of top post bracket.

D. Lumenrail LED Lighted Railing:

1. Insert LED light stick into Wagner slotted tube.
    a. Source: Selected high brightness LED
    b. Life (L70/ 70% brightness): 50,000 hours
    c. Light Output: Lumenrail Standard Output, 235Lumens/ft, 3000K, Beam Angle: 70°
    d. Housing: Extruded Aluminum
    e. Mounting: Clip System
    f. Listings: ETL Listed for wet or dry locations.
    g. Length: 24"
    h. Power Requirement: 24V
    i. Power Consumption: Lumenrail 4 W/ft
    j. Power Supply: 24V/100W
    k. Input Voltage to Power Supply: 120V
    l. Temperature Range: -40° C through +60° C
    m. Product Rating: Interior and Exterior Applications, ETL, Class 2 circuit.

2.4 FASTENERS

A. All mechanical fasteners used in the assembly of stainless steel or aluminum railings shall be manufactured from stainless steel.

B. Cement: Hydraulic, ASTM C 595, factory prepared with accelerator.

2.5 HANDRAIL BRACKETS

A. Aluminum

B. Check governing codes for dimensional and structural requirements.

2.6 FABRICATION

A. Form rail-to-end post connections and all changes in rail direction by radius elbows.

B. Cut material square and remove burrs from all exposed edges, with no chamfer.

C. Make exposed joints butt tight and flush.

D. Close exposed ends of [pipe] [tube] [handrail] by use of appropriate end cap.

E. For posts set in concrete, furnish matching sleeves or inserts not less than 5 inches long.

F. Verify dimensions on site prior to shop fabrication.

PART 3 EXECUTION

3.1 PREPARATION

A. Supply items to be cast in concrete, embedded in masonry.

B. Examine areas to receive railing system. Notify Architect if areas are not acceptable. Do not begin installation until unacceptable conditions have been corrected.

3.2 METAL INTERACTION

A. When aluminum components come into contact with dissimilar metals, surfaces shall be kept from direct contact by painting the dissimilar metal with a heavy coat of a proper primer.

B. When aluminum components come into contact with cement or lime mortar, exposed aluminum surfaces shall be painted with zinc chromate.

3.3 INSTALLATION

A. Install in accordance with shop drawings [and manufacturer’s instructions] at locations indicated on the drawings.

B. Erect horizontal or parallel to rake of steps or ramp, rigid, and free from distortion or defects detrimental to appearance or performance.

3.4 PROTECTION

A. Protect railing system and finish from damage during construction.

3.5 CLEANING

A. As installation is completed, wash thoroughly using clean water and soap; rinse with clean water.

B. Do not use acid solution, steel wool or other harsh abrasives.

C. If stain remains after washing, remove finish and restore in accordance with NAAMM/NOMMA Metal Finishes Manual.

D. Finish must not be removed from anodized aluminum. Reanodizing can only be done by removing railing and returning it to the anodizer.

3.6 REPAIR OF DEFECTIVE WORK

A. Remove stained or otherwise defective work and replace with material that meets specification requirements.

B. Repair damaged finish as directed by Architect

C. Replace defective or damaged components as directed by Architect.

END OF SECTION 265000

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) 1989 (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 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, with Editorial Revision (2022).

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 2022.

D. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code) 1989 (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 (Reapproved 2022).

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 Duct 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 27 1000
STRUCTURED CABLING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Communications system design requirements.
B. Communications pathways.
C. Copper cable and terminations.
D. Communications equipment room fittings.
E. Communications outlets.
F. Communications grounding and bonding.
G. Communications identification.
H. Cabling testing procedures.

1.02 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Division 07 - Firestopping.
C. Division 26 - Grounding and Bonding for Electrical Systems.
    1. Includes intersystem bonding termination.
    2. Includes bonding jumpers for bonding of communications systems and electrical system grounding.
D. Division 26 - Conduit for Electrical Systems.
E. Division 26 - Cable Trays for Electrical Systems.
F. Division 26 - Boxes for Electrical Systems.
G. Division 26 - Underfloor Raceways for Electrical Systems.
H. Division 26 - Identification for Electrical Systems: Identification products.
I. Division 26 - Wiring Devices.

1.03 DEFINITIONS

A. BICSI: Building Industry Consulting Services International
B. EIA: Electronic Industries Association
C. TIA: Telecommunications Industries Association
D. UL: Underwriters Laboratory
E. NFPA: National Fire Protection Association

1.04 REFERENCE STANDARDS

A. ANSI/TIA-1152-A - Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling.

B. ANSI/TIA-568-0.D - Generic Telecommunications Cabling for Customer Premises.

C. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition 2019.

D. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment Revision E, 2005.

E. FM (AG) - FM Approval Guide current edition.

F. ICEA S-83-596 - Indoor Optical Fiber Cables 2016.

G. ICEA S-90-661 - Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables (With or Without An Overall Shield) For Use in General Purpose and LAN Communications Wiring Systems Technical Requirements 2012.

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

I. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices 1988a (Reaffirmed 2012).

J. TIA-492AAAA - Detail Specification for 62.5-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers 2009b.

K. TIA-492AAAB - Detail Specification for 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers 2009a.

L. TIA-492AAAC - Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers 2009b.

M. TIA-492AAAD - Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers 2009.

N. TIA-492CAAA - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers 1998 (Reaffirmed 2002).

O. TIA-492CAAB - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak 2000 (Reaffirmed 2005).

P. TIA-526-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant 2015a.

Q. TIA-526-14 - Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant 2015c.

R. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set 2019.

S. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standard 2018d.

T. TIA-568.3 - Optical Fiber Cabling and Components Standard 2016d.

U. TIA-569 - Telecommunications Pathways and Spaces 2019e.

V. TIA-570 - Residential Telecommunications Infrastructure Standard 2018d.

W. TIA-598 - Optical Fiber Cable Color Coding 2014d.

X. TIA-606 - Administration Standard for Telecommunications Infrastructure 2017c.

Y. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises 2019d.

Z. UL (DIR) - Online Certifications Directory Current Edition.

AA. UL 444 - Communications Cables Current Edition, Including All Revisions, and Edition 5, 2017.

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

CC. UL 1651 - Fiber Optic Cable Current Edition, Including All Revisions.

DD. UL 1863 - Communications-Circuit Accessories Current Edition, Including All Revisions.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.
   2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
   3. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Arrange for Communications Service Provider to provide service.

C. Preinstallation Meeting: Convene one week and one month prior to commencing work of this section to review service requirements and details with Communications Service Provider representative.

1.06 SUBMITTALS

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

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

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

D. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).

E. Evidence of qualifications for installer.

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, installation, and operation of product.

G. Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 60 days prior to intended test date.

H. Field Test Reports.

I. Copper and Fiber Test reports. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

J. Installation contractor shall register all copper and fiber test results with the manufacturer(s) to attain the manufacturers extended warranty on labor an material. The manufacturer's approved documentation shall be delivered to the Owner.

K. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
   1. Record actual locations of outlet boxes and Data Rooms.
   2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
   3. Identify Data Rooms and equipment rooms by room number on drawings.

L. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents

1.07 QUALITY ASSURANCE

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

B. Manufacturer Qualifications: At least 3 years experience manufacturing products of the type specified. experience in the installation and testing of the type of system specified, and:

C. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
   1. Employing a BICSI Registered Communications Distribution Designer (RCDD).
   2. Supervisors and installers factory certified by manufacturers of products to be installed.
   3. Employing BICSI Registered Cabling Installation Technicians (RCIT) for supervision of all work.

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.

F. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

G. Grounding: Comply with ANSI-J-STD-607-A.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Keep stored products clean, dry and in a temperature permitted by the manufacturer.

C. Test cables upon receipt at Project site.
   1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
   2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
   3. Test each pair of UTP cable for open and short circuits.

1.09 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a 2 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN

A. Provide a complete permanent system of cabling and pathways for voice, data, audio visual, and security communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
   1. Comply with TIA-568 (SET) (cabling) and TIA-569 (pathways) (commercial standards).
   2. Comply with TIA-570 (residential standard).
   3. Comply with Communications Service Provider requirements.
   4. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.

5. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F (0 to 60 degrees C) at relative humidity of 0 to 95 percent, noncondensing.
6. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.

B. System Description:
1. Building Entrance Cable: By others.
2. Horizontal - Provide Category 6A plenum voice and data cabling and outlets per drawings.
3. Provide outlets where indicated on drawings.

C. Equipment Room (ER)/ Main Distribution Frame (MDF): Centrally located support structure for terminating horizontal cables that extend to telecommunications outlets, functioning as point of presence to external service provider.

D. Cabling to Outlets: Specified horizontal cabling, wired in star topology to Equipment Room or Telecommunication Room located at center hub of star; also referred to as "links".

2.02 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-C.

B. Cable Support: NRTL labeled for support of Category 5E and above cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

C. Conduit: As specified in Division 260533.13; provide pull cords in all conduit.

D. Cable Trays: As specified in Division 260536.

E. Underfloor Ducts: As specified in Division 260539.

F. Overhead Service Entrance: Weatherhead or service entrance fitting located on outside of building with galvanized rigid steel or intermediate metallic conduit running to entrance facility.

G. Underground Service Entrance: Rigid polyvinyl chloride (PVC) conduit, Schedule 40.

H. 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.

2.03 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA/EIA-569-C.

C. Comply with BICSI TDMM, "Firestopping System" Article.

2.04 COPPER CABLE AND TERMINATIONS

A. Manufacturers:
1. Berk-Tek
2. Superior Essex
3. Belden
4. Leviton
5. Hubbell Premise Wiring

6. Panduit
7. Siemon
8. Substitutions: See Section 016000 - Product Requirements.

B. Copper Horizontal Cable:
1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2 and listed and labeled as complying with UL 444.
2. Cable Type: Voice and Data: TIA-568.2 Category 6A UTP (unshielded twisted pair); 23 AWG.
3. Cable Capacity: 4-pair.

C. Cable Applications: Use listed NFPA 70 Type CMP plenum cable unless otherwise indicated.

D. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.

E. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.
1. Performance: 500 mating cycles.
2. Voice and Data Jacks: 8-position modular jack, color-coded for both T568A and T568B wiring configurations.

2.05 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

A. Copper Cross-Connection Equipment:
1. Manufacturers:
a. Belden
b. Leviton
c. Hubbell Premise Wiring
d. Panduit
e. Siemon
f. Substitutions: See Section 016000 - Product Requirements.
2. Connector Blocks for Category 3 Cabling: Type 66 insulation displacement connectors; capacity sufficient for cables to be terminated plus 25 percent spare.
3. Connector Blocks for Category 5e and Up Cabling: Type 110 insulation displacement connectors; capacity sufficient for cables to be terminated plus 25 percent spare.
4. Patch Panels for Copper Cabling: Sized to fit EIA/ECA-310 standard 19 inch (482.6 mm) wide equipment racks; 0.09 inch (2.2 mm) thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface.
a. Jacks: Non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.
b. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
c. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
d. Provide incoming cable strain relief and routing guides on back of panel.

B. Backboards: Interior grade plywood without voids, 3/4 inch (19 mm) thick; UL-labeled fire-retardant.
1. Size: As indicated on drawings.
2. Do not paint over UL label.

C. Equipment Frames, Racks and Cabinets:
1. Manufacturers:
a. Chatsworth
b. Great Lakes
c. Hubbell Premise Wiring

d. Panduit
e. Siemon
f. Substitutions: See Section 016000 - Product Requirements.

2. Component Racks: EIA/ECA-310 standard 19 inch (482.6 mm) wide.
3. Wall Mounted Racks: Steel construction, hinged to allow access to back of installed components.
4. Floor Mounted Racks: Aluminum or steel construction with corrosion resistant finish; vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug.
   a. Load rating: pounds (kg).
5. Freestanding Cabinets: Front and rear doors with locks; removable side panels with locks; vented top and rear door; adjustable leveling feet; cable access in roof and base; grounding bar.
   a. Roof mounted fan, capacity [_____].
6. Wall Mounted Cabinets: Front doors with locks, louvered side panels, top and bottom cable access, and ground lug.
   a. Cover inside of cabinet back with plywood backboard as specified.
   b. Duplex AC power outlet inside cabinet.
7. Cabinets: Steel construction with corrosion resistant finish.
8. Locks: Keyed alike.

D. Cable Management:
1. Manufacturers:
   a. Chatsworth
   b. Great Lakes
   c. Hubbell Premise Wiring
   d. Panduit
   e. Siemon
   f. Substitutions: See Section 016000 - Product Requirements.

2.06 COMMUNICATIONS OUTLETS

1. Manufacturers:
2. Belden
3. Leviton
4. Hubbell Premise Wiring
5. Panduit
6. Siemon
7. [_____]

B. Outlet Boxes: Comply with Section 26 0533.16.
1. Provide depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
2. Minimum Size, Unless Otherwise Indicated:
   a. Wall Phone Only Outlets: 4 inch by 2 inch by 2-1/8 inch deep (100 by 50 by 54 mm) trade size.
   b. Data or Combination Voice/Data Outlets: 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.
   c. Fiber Optic Outlets: 4-11/16 inch square by 2-1/8 inch deep (119 by 54 mm) trade size.

C. Wall Plates:
1. Comply with system design standards and UL 514C.
2. Accepts modular jacks/inserts.
3. Capacity:

a. Wall Phone Only Outlets: 1 ports.
b. Data or Combination Voice/Data Outlets: 4 ports.

D. Wall Plate Material/Finish - Flush-Mounted Outlets: Match wiring device and wall plate finishes specified in Section 26 2726.

E. GROUNDING AND BONDING COMPONENTS
1. Comply with TIA-607.
2. Comply with Section 260526.

F. IDENTIFICATION PRODUCTS
1. Comply with TIA-606.
2. Comply with Section 260553.

G. SOURCE QUALITY CONTROL
1. See Section 014000 - Quality Requirements, for additional requirements.
2. Factory test cables according to TIA-568 (SET).

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569 (pathways), TIA-607 (grounding and bonding), BICSI N1, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

B. Comply with latest editions and addenda of TIA-570, TIA-607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

C. Coordinate backbone cabling with required protectors and demarcation point provided by the communications service provider.

D. Comply with Communication Service Provider requirements.

E. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.

F. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

3.02 INSTALLATION OF PATHWAYS

A. Install pathways with the following minimum clearances:
1. 48 inches (1220 mm) from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
2. 12 inches (300 mm) from power conduits and cables and panelboards.
3. 5 inches (125 mm) from fluorescent and high frequency lighting fixtures.
4. 6 inches (150mm) from flues, hot water pipes, and steam pipes.

B. Conduit, in Addition to Requirements of Section 26 0533.13:
1. Arrange conduit to provide no more than the equivalent of two 90 degree bend(s) between pull points.
2. Conduit Bends: Inside radius not less than 10 times conduit internal diameter.
3. Arrange conduit to provide no more than 100 feet (30 m) between pull points.
4. Do not use conduit bodies.
5. Minimum Cover - Underground Service Entrance: Comply with NFPA 70 and Communications Service Provider requirements.

C. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

D. Outlet Boxes:
1. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of telecommunications outlets provided under this section.
   a. Mounting Heights: Unless otherwise indicated, as follows:
      1) Telephone and Data Outlets: 18 inches (450 mm) above finished floor.
      2) Wall mounted Telephone Outlets: 48 inches (1.2 m) above finished floor to top of telephone.
   b. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
   c. Provide minimum of 24 inches (600 mm) horizontal separation between flush mounted outlet boxes installed on opposite sides of fire rated walls.
   d. Unless otherwise indicated, provide separate outlet boxes for line voltage and low voltage devices.
   e. Locate outlet boxes so that wall plate does not span different building finishes.
   f. Locate outlet boxes so that wall plate does not cross masonry joints.

3.03 INSTALLATION OF EQUIPMENT AND CABLING

A. Cabling:
1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
2. Do not over-cinch or crush cables.
3. Do not exceed manufacturer's recommended cable pull tension.
4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.

B. Wiring Method: Install cables in raceways and J-hooks except where cable trays are required in Drawings. Conceal raceway and cables except in unfinished spaces.
1. 1. Install plenum cable in environmental air spaces, including plenum and non-plenum ceilings.

C. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

D. All exposed cabling shall be installed within conduit. Conduit in exposed areas shall match the color of the wall or ceiling it is attached to. Only exceptions are in data rooms, mechanical spaces, and above concealed ceilings.

E. Pre-terminated fiber optic cabling will be accepted. All devices mandated within this specification shall be used to make up this pre-terminated cable.

F. Cabling Installation:
1. Install 110-style IDC termination hardware unless otherwise indicated.
2. MUTOA shall not be used as a cross-connect point.
3. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors.
4. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.

5. Locate consolidation points for UTP at least 49 feet from communications equipment room.
6. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

G. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
1. At Distribution Frames: 120 inches (3000 mm).
2. At Outlets - Copper: 12 inches (305 mm).
3. At Outlets - Optical Fiber: 39 inches (1000 mm).

H. Copper Cabling:
1. Category 5e and Above: Maintain cable geometry; do not untwist more than 1/2 inch (12 mm) from point of termination.
2. For 4-pair cables in conduit, do not exceed 25 pounds (110 N) pull tension.
3. Use T568B wiring configuration.

I. Wall-Mounted Racks and Enclosures:
1. Install to plywood backboards only, unless otherwise indicated.
2. Mount so height of topmost panel does not exceed 78 inches (1980 mm) above floor.

J. Floor-Mounted Racks and Enclosures: Permanently anchor to floor in accordance with manufacturer's recommendations.

K. Floor-Mounted Enclosures: Connect adjacent cabinets together and remove interior side panels.

L. Identification:
1. Use wire and cable markers to identify cables at each end.
2. Use manufacturer-furnished label inserts, identification labels, or engraved wallplate to identify each jack at communications outlets with unique identifier.
3. Use identification nameplate to identify cross-connection equipment, equipment racks, and cabinets.
4. Labels shall meet the legibility, defacement, exposure, and adhesion requirements of UL 969.
5. Labels shall be preprinted using a mechanical means of printing (e.g. laser printer)
6. Where used for cable marking, provide vinyl substrate with a white printing area and a clear "tail" that self laminates the printed area when wrapped around the cable. If cable jacket is white, provide cable label with printing area that is any other color than white, preferable orange or yellow - so that labels are easily distinguishable.
7. Where insert type labels are used provide clear plastic cover over label.
8. Provide plastic warning tape 6 inches wide continuously printed and bright colored 18" above all direct buried services, underground conduits, and duct-banks.

3.04 FIELD QUALITY CONTROL

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

B. Comply with inspection and testing requirements of specified installation standards.

C. Provide all labor, materials, tools, field-test instruments and equipment required for the complete testing, identification, and administration of the work called for in the Contract Documents.

D. Only test results with a PASS will be accepted. Field-test results with of a *PASS will be rejected.

E. Testing shall be performed on each cabling link. (100% Testing)

F. All Tests shall be documented.

G. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
   1. Manufacturer of the connectors or cable.
   2. Manufacturer of the test equipment used for the field certification.
   3. Training Organizations (BICSI, Equivalent)

H. The Owner or the Owner's representative may select a random sample of five percent of the installed service links. The Owner or the Owner's representative shall test these randomly selected links. The results obtained shall be compared to the data provided by the installation contractor. If more than two percent of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the representative shall repeat 100 percent testing at no cost to the Owner.

I. Engage a qualified testing agency to evaluate cables.

J. Cable will be considered defective if it does not pass tests and inspections.

K. Visual Inspection:
   1. Inspect cable jackets for certification markings.
   2. Inspect cable terminations for color coded labels of proper type.
   3. Inspect outlet plates and patch panels for complete labels.
   4. Inspect patch cords for complete labels.
   5. Inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

L. Category 6A Modular Plug Termination Link Testing Requirements:
   1. Each cabling link shall be tested for:
      a. Wire Map
      b. Length
      c. Propagation Delay
      d. Delay Skew
      e. DC Loop Resistance
      f. Insertion Loss
      g. NEXT (Near-End Cross Talk)
      h. PS NEXT (Power Sum Near-End Cross Talk)
      i. ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
      j. ACR-F (Attenuation to Crosstalk Ratio Far-End)
      k. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
      l. Return Loss
   2. All installed cabling Modular Plug Terminated Links shall be field-tested and pass the test requirements and analysis as dictated by the Manufacturer to achieve the extended warranty. Any Modular Plug Terminated Link that fails these requirements shall be diagnosed and corrected until the Modular Plug Terminated Links meets the performance

requirements. The final and passing results of the tests for all Modular Plug Terminated Links shall be provided in the test results documentation.

3. Modular Plug Terminated Links shall comply with the Permanent Link transmission requirements of the ANSI/TIA-568-2.D standard.
    a. The MPTL shall be tested with a Permanent Link Adapter on the Main Unit and a Patch Cord Adapter suitable for Category 6A testing on the Far End or Remote Test Equipment
4. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with the Contract Documents and to the satisfaction of the Owner.

M. Category 5e and Above Permanent Link Testing Requirements:
1. Each Cabling Link shall be tested for:
    a. Wire Map
    b. Length
    c. Propagation Delay
    d. Delay Skew
    e. DC Loop Resistance
    f. DC Resistance Unbalance within a pair
    g. DC Resistance Unbalance between pairs
    h. Insertion Loss
    i. NEXT (Near-End Cross Talk)
    j. PS NEXT (Power Sum Near-End Crosstalk)
    k. ACR-N (Attenuation to Crosstalk Ratio Near-End)
    l. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
    m. ACR-F (Attenuation to Crosstalk Ratio Far-End)
    n. Return Loss
    o. TCL (Transverse Conversion Loss)
    p. ELTCTL (Equal Level Transverse Conversion Transfer Loss)
2. All installed cabling Permanent Links shall be field-tested and pass the test requirements and analysis as dictated by the Manufacturer for the extended warranty. Any Permanent Link that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected Permanent Link meets performance requirements. The final and passing result of the tests for all Permanent Links shall be provided in the test results documentation.
3. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with the Contract Documents and to the satisfaction of the Owner.

N. Cable Testers:
1. The field-test instrument shall be within calibration period recommended by the manufacturer. Minimum calibration is 12 months prior to testing.
2. The tester shall have Level IIIe accuracy in accordance with ANSI/TIA-1152-A
3. The tester must be capable of storing > 10,000 results for all measurements listed above.
4. Acceptable Manufacturers:
    a. Fluke Networks

O. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
1. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.

2. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

END OF SECTION 27 1000

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SECTION 28 0500
SECURITY CONDUCTOR CABLES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. System Requirements
B. Cabling

1.2 RELATED REQUIREMENTS

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

1. Division 07 - Firestopping.
2. Division 08- Door Hardware: Electrically operated door hardware, for interface with access control system. Includes door hardware with integral request to exit devices.
3. Division 26 - Parking Control Equipment: Parking gates, for interface with access control system.
4. Division 14 - Electric Traction Elevators: For interface with access control system.
5. Division 14 - Hydraulic Elevators: For interface with access control system.
6. Division 26 - Grounding and Bonding for Electrical Systems.
7. Division 26 - Conduit for Electrical Systems.
8. Division 26 - Identification for Electrical Systems: Identification products and requirements.
9. Division 27 - Structured Cabling: Data cables for access control system IP network connections.
10. Division 28 - Video Surveillance: For interface with access control system.
11. Division 28 -Building Intrusion Detection: For interface with access control system.
12. Division 26 - Fire Detection and Alarm: For interface with access control system.

B. Refer to the following construction documents for Data Room locations and device locations only.

1. “T” Drawings – Technology Plans

C. Any apparatus, appliance, material, or work not shown on the Drawings but mentioned in the Specifications, or vice versa, and any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation, even if not particularly specified, shall be provided without additional expense. Coordinate with each system manufacturer to ensure all hardware, firmware, relays, or other necessary components are provided prior to bid submission.
D. All work of this Section to comply with the requirements of the Conditions of Contract, with all Specification Sections of Division 01 – General Requirements, with the Security Drawings, and with all other Contract Documents.
E. Refer to Division 26 of the Contract Documents, Electrical, for all Specifications governing the installation of raceway (conduit, EMT, cable trays, wire trough, etc.), system junction and pull

boxes, and device rough-in boxes, for all Security System work shown on the Security Drawings. Conduit, back box, and trough work to be provided by this Contractor.

F. Refer to Division 26 of the Contract Documents, Electrical, for all work related to the interconnection of Security System equipment to 120 VAC power sources.
G. Refer to Division 09 of the Contract Documents, Finishes, for details relating to acoustical ceilings and gypsum board systems, floor finishes, painting, etc., for information pertinent to device and back box selection and installation.
H. Refer to Division 08 of the Contract Documents, Openings, for details relating to doors, door frames, windows, and window frames, for information pertinent to the selection of magnetic contact devices and their associated placement and installation, including back box selection and installation.
I. Refer to Division 08 of the Contract Documents, Openings, for details relating to door and door frame hardware and preparation, electrified lock power supplies, required coordination to accommodate these components and/or systems, lock voltage and current draw coordination, coordination of fail-safe electrified locks, and any other related equipment or requirements
J. Refer to Division 06, Wood, Plastics, Composites, and coordinate all desk locations and installation details with the Millwork Contractor.
K. Review all other Specification Sections as required to achieve complete inter- trade coordination.

1.3 DEFINITIONS

A. “Project Manager” shall mean the Owner’s appointed representative.
B. “As Necessary” shall mean work which is required for completed construction, but is not necessarily shown or described in the Contract Documents.
C. “As Required” shall mean work which is required for completed construction and is shown on the drawings or described in the project specification.
D. “Install” shall mean to set in place complete with all mounting facilities and connections as required ready for normal use of service
E. “Substantial Completion” shall mean that the project is sufficiently complete to be utilized for its intended use as stated in the body of this written specification.
F. “Conduit” shall include all fittings, sleeves, connections, hangers and other accessories related to such conduit.
G. “Surface Metal Raceway” shall include all fittings, sleeves, connections, hangers and other accessories related to such raceway.
H. “Concealed” shall mean hidden from sight, as in chases, furred spaces, shafts, fixed ceiling or embedded in construction.
I. “Exposed”, shall mean not “concealed” as defined above.
J. “Governmental” shall mean all municipal, state and federal government agencies.
K. The words “Furnish”, “Supply” and “Provide” shall mean purchase, deliver to the job site, protect and provide interim storage and install in accordance with manufacturer’s specifications.
L. Words “Approved Equal” shall mean any product which in the opinion of the Technology Consultant is equal in quality, arrangement, appearance, and performance to the product specified.
M. “Cabling” shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.
N. “Product” shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.
O. Words in the singular shall also mean and include the plural, wherever the context so indicates, and words in the plural shall mean the singular, wherever the context so indicates.
P. “Contractor” refers to the biding/installation Contractor responsible for furnishing and installation of all work indicated within this specification.

1.4 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. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
D. UL 294 - Access Control System Units; Current Edition, Including All Revisions.
E. UL 1076 - Proprietary Burglar Alarm Units and Systems; Current Edition, Including All Revisions.
F. System shall be RoHS (Restriction of Hazardous Substances) compliant and meet proposed amendments to the reduction of toxic substances in manufacturing in stated in the Environmental Design of Electrical Equipment Act (EDEE).
G. Installation shall comply with NECA 1-2010 “Standard Practice of Good Workmanship in Electrical Construction”
H. Installation shall comply with NEC/NFPA 70E “Standard for Electrical Safety in the Workplace”
I. Electronic data exchange between Video Surveillance System and the Access Control System shall comply with SIA TVAC
J. Installation shall comply with FCC CFR 47 Part 15 Class A “Telecommunications, Radio, Frequency, Digital Device Emission:
K. Installation shall comply with Federal, State, and Local Codes and Authority Having Jurisdiction (AHJ).
L. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other installers to provide suitable security wiring for all security systems.

1.6 SUBMITTALS

A. See Division 01 – Administrative Requirements for submittal procedures.
B. Evidence of Qualifications for Installer:

1. The Contractor shall be a bona fide security systems contractor, licensed by the State of Connecticut for the installation of the low voltage security and signal communication systems, and engaged in security system maintenance, service and contracting for at least the last five years.
2. The Contractor shall employ technicians who have been trained by the Manufacturer specified within this section to install the systems of this Manufacturer.
3. The contractor shall be a factory authorized stocking distributor of the manufacturer of the equipment included in the system so that immediate replacement parts can be made from inventory and service provided as needed on an emergency basis.
4. The Contractor shall submit with the bid a manufacturer’s certificate of acceptance of the qualifications of the Installing Contractor to install, test, maintain and repair the manufacturer’s equipment.
5. In order for the Security Consultant to verify that they meet the competency requirements of this specification, Contractors must submit the following information if so requested:

a. Proof that the Contractor has installed, services and maintained similar security systems for a minimum of ten (10) years.
b. Proof that the Contractor is a firm which currently and regularly installs, services and maintains security systems as a full time business.
c. The names and qualifications of security system technicians that shall perform and supervise the work and perform tests or adjustments on the systems and equipment. Qualifications shall include all schooling, training, and history of work experience.
d. A list of four prior systems comparable to the one specified under this contract which were installed, serviced, and maintained satisfactorily by the Contractor for a minimum of one (1) year. Each system listed shall include the firm or owner, location, person to contact (with telephone number), date of installation and service period, and a brief description of the system and work performed on the system.

6. The Contractor shall submit any other information required by the Security Consultant to determine the competency of the Contractor. If this information is not submitted as requested, it shall be submitted within the time specified by the Architect after the bid opening. If the Contractor fails to submit the information in accordance with the Security Consultant's request, the Contractor shall be declared non-responsive, and may be rejected to perform the work specified within this section.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instruction for storage, handling, protection, examination, preparation, installation, and operation of product.
D. Manufacturer's detailed field-testing procedures.
E. Product Data: Provide details and technical specifications for each product indicated. Include physical dimensions, features, performance, electrical characteristics, ratings, software versions, and operating system details.

1. Equipment Submittals

a. Provide a Title Page, with project name, Contractor's name and address, contact information, date of submission, and submission revision number.
b. Provide a Parts List, for proposed equipment, materials, components and devices, listing the following information for each line item:

1) The system type
2) Model number
3) Specification sheet page reference

c. Provide Manufacturers Specification Sheet with descriptive information for equipment, materials, components and devices. Number each page, to correspond with the Parts List.
d. Clearly delineate (with highlighter, arrow, or underline) on each specification sheet, specific model numbers, options and configurations being proposed for this project.
e. Indicate kinds of materials and finishes for equipment where more than one option is presented.

2. Acceptance Testing Plan

a. Submit a written document detailing the test procedures to be followed in evaluating and proving the installed system(s).

b. Provide a sample of the test forms to be used for each system and for each component of each system.
c. Include all tests required by the equipment manufacturer and by this Specification

3. Incomplete or unchecked submittals which do not contain complete data on the work and full information on related matters will be returned for correction.

F. CE and FCC Compliance Certificates:
G. Field quality-control reports
H. Current Specified Manufacturer Integrator Certification Letter
I. Current Specified Manufacturer Training Certificates (listing expiration dates) for Two technicians from the supporting office
J. Warranty: Software support and warranty information for all components, including Service Level Agreement (SLA) details, and duration of agreement from date of system acceptance by Owner. Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
K. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

1.7 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70.
2. NFPA 101 (Life Safety Code).
3. The requirements of the local authorities having jurisdiction.
4. Applicable TIA/EIA standards.

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. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with access control systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer's representative.

1. Contract maintenance office located within 100 miles (160 km) of project site.

E. Maintenance Contractor Qualifications: Same entity as installer.
F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
G. The requirements of the State Building Code and local regulations establish the minimum acceptable quality of workmanship and materials, and all work shall conform thereto unless more stringent requirements are indicated or specified herein.
H. All work shall comply with the latest editions of the codes as referenced herein.
I. Follow manufacturer's directions for articles furnished, in addition to directions shown on drawings or specified herein.
J. Protect all work, materials, and equipment from damage during process of work. Replace all damaged or defective work, materials and equipment without additional cost to DCAMM.

K. All equipment and materials for permanent installation shall be the products of recognized manufacturers and shall be new.
L. Equipment and materials shall:

1. Where normally subject to Underwriters Laboratory Inc. listing or labeling services, be so listed or labeled.
2. Be without blemish or defect.
3. Not be used for temporary purposes.
4. Be in accordance with the latest applicable NEMA standards.
5. Be products which will meet with the acceptance of all authorities having jurisdiction over the work. Where such acceptance is contingent upon having the products examined, tested and certified by Underwriters or another recognized testing laboratory, the product shall be so examined, tested and certified.

M. Except for conduit, conduit fittings, outlet boxes, wire and cable, all items of equipment or material of one generic type shall be the product of one manufacturer throughout.
N. For items which are to be installed but not purchased as part of the electrical work, the electrical work shall include:

1. The coordination of their delivery.
2. Their unloading from delivery trucks driven into any point on the property line at grade level.
3. Their safe handling and field storage up to the time of permanent placement in the project.
4. The correction of any damage, defacement or corrosion to which they may have been subjected. Replacement, if necessary, shall be coordinated with Contractor who originally purchased the item.
5. Their field make up and internal wiring as may be necessary for their proper operation.
6. Their mounting in place including the purchase and installation of all dunnage, supporting members, and fastenings necessary to adapt them to architectural and structural conditions.
7. Their connection to building wiring including the purchase and installation of all termination junction boxes necessary to adapt and connect them to this wiring. Included also shall be the purchase and installation of any substitute lugs or other wiring terminations as may be necessary to adapt their terminals to the building wiring as called for and to the connection methods set forth in these specifications.

O. Items which are to be installed but not purchased as part of the electric work shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the electric work will be considered only if presented in writing within one week of the date of delivery to the project of the items in question. The work includes all procedures, regardless of how extensive, necessary to put into satisfactory operation, all items for which no claims have been submitted as outlined above.
P. Seismic Performance: Provide equipment capable of withstanding the effects of earthquake motions determined according to ASCE/SEI 7 and current building codes for the state of CT.

1. The term “withstand” means “the system(s) will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event.”

1.8 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Interior, Controlled Environment: System components installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F (2 to 50 deg C) dry bulb and twenty to ninety percent (20-90%) relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
2. Interior, Uncontrolled Environment: System components installed in non- temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and twenty to ninety percent (20-90%) relative humidity, noncondensing. Use NEMA 250, Type 3R enclosures.
3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and twenty to ninety percent (20-90%) relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick. Use sufficiently rated NEMA 250 enclosures.
4. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
5. Corrosive Environment: System components subject to corrosive fumes, vapors, and wind-driven salt spray in coastal zones. Use sufficiently rated NEMA 250 enclosures.
6. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.9 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.

1.10 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.11 WARRANTY

A. See Division 01 – Closeout Submittals for additional warranty requirements.
B. The Integrator guarantees the Systems to be installed under this specification to be free from any defects in workmanship and materials for a period of one (1) year from the date of final completion/acceptance of the project by the Owner as evidenced by the date of final payment for the work. The Contractor shall promptly and at their own expense remedy any defects in the work and pay for any damage to other work resulting thereof, which shall appear during the period of time covered by this guarantee. Neither the final certificate of payment nor any provisions in this Agreement shall constitute an acceptance of work not done in accordance with this specification or relieve the Contractor of liability with respect to any expressed warranties or guarantees or responsibility for faulty materials or workmanship.

C. Submit manufacturer's standard warranties.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. Furnish and install Electronic Security System cabling consisting of required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
B. It is the responsibility of the contractor awarded this project to ensure the cable used is approved by the equipment manufacturer for its intended use and will meet environmental and distance requirements.
C. Shields and twisted wire are required unless PROHIBITED by the Access Control or Intrusion Detection Manufacturer.
D. 20 AWG is a minimum wire size unless PROHIBITED by the Access Control and Intrusion Detection Manufacturer.

2.2 CABLING:

A. All cabling shall be plenum rated.
B. Approved Manufacturer's:

1. Belden
2. West Penn

C. System Cable: Provide cable as shown below or as recommended by the Manufacturer.

1. Low Voltage Security Alarm Signal Cable shall be twisted, single pair, shielded cable, with shield drain wire, with overall jacket, gauge calculated to compensate for length of run and current requirements. All conductors for security zone signal to be minimum #20 AWG, UL listed. All wires to be color coded. One pair #20 AWG per security device zone required.
2. Low Voltage Security Power, 12 VDC cable shall be minimum of #18 AWG for runs up to 150,' and a minimum of #16 AWG for runs up to 300,' twisted, shielded stranded, with shield drain wire, UL listed, jacketed, pair, separate color code from any other power circuits.
3. Electric Lock Power Cable shall be minimum of #14 AWG for runs up to 200' serving a single lock. Twisted, shielded, stranded, jacketed pair, UL listed, separate color ode from any other power circuits.
4. Composite Cable (Reader, Lock, Monitor, REX): CAT6 jacketed Plenum cable with overall shield, including (6) Conductor Shielded 22AWG w/ripcord, 4-Conductor 22AWG w/ripcord, 4-Conductor 22AWG w/ripcord, and 4-Conductor 18 AWG w/ripcord; or equal with written approval by Security Consultant.
5. Lock Power, at Double Doors: Jacketed Plenum cable, unshielded, 4-conductor 18 AWG (7-strand), unshielded, or approved equal.
6. Request-to-Exit Cable, at Double Doors: Plenum rated jacket, 4-conductor 22 AWG (7- strand), unshielded, or approved equal.
7. Special Control Cable, at Double Emergency Exit Doors with Power Booster: Plenum rated cable, 4-conductor 12 AWG (19 strand), unshielded, or approved equal.
8. Card Reader Cable for second card reader at same portal: 3 Pair Shielded 22AWG or approved equal.

9. Alarm Monitoring: 1Pair Shielded 22AWG, or equal.
10. Area Motion Detector: 2 Pair Shielded 20AWG, or equal.
11. Push Buttons: 2 Conductor 18AWG.
12. Lockdown Buttons: 2 Pair Shielded 18AWG, or equal
13. Data: 2 Pair Shielded 20AWG, or equal.
14. Strobe: 2 Pair Shielded 18AWG, or equal.
15. Network Cable: CAT 6, or as required by Division 27, whichever is more stringent.

D. Cable installed below grade shall be rated for immersion in water.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that ratings and configurations of system components are consisted with the indicated requirements.
C. Verify that mounting surfaces are ready to receive the system components.
D. Verify that branch circuit wiring is installed, completed, tested, and ready for connection to system.
E. Verify that conditions are satisfactory prior to starting work.
F. Device Locations

1. All device locations are to be field verified with the Owner prior to start of project. Architectural drawings are for approximation purposes only. Additional charges will not be allowed for outlet installation in areas not reviewed or approved by the Owner.

G. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.
H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install access control system in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer’s instructions.
C. Unless otherwise indicated, use wiring in conduit.

1. Use suitable listed cables in we locations, including underground raceways.
2. Use suitable listed cables for vertical wire applications.
3. All cabling shall be plenum rated.
4. Install wiring in conduit for the following:

a. Where required for rough-in.
b. Where required by the AHJ.
c. Where exposed to damage.
d. Where installed outside the building.
e. For exposed connections from outlet boxes to devices.

5. Conduit: comply with Division 28 0528

6. Conceal cables unless specifically indicated to be exposed.
7. User power transfer hinges specified within Division 08 for concealed connections to door hardware.
8. Cables in the following areas may be exposed:

    a. Equipment Closets

9. Route exposed cables in parallel or perpendicular to building structural members and surfaces.
10. Do not exceed manufacturer's recommended maximum cable length between components.

D. Provide grounding and bonding in accordance with Division 26.
E. Install firestopping to preserve the fire resistance rating of partitions and other elements, using materials and methods specified in Division 07.
F. Install power supplies and other auxiliary components at control stations unless otherwise indicated.
G. Identify system components, wiring, cabling, and terminals according to ANSI/EIA/TIA standards.
H. Wiring may be run in concealed spaces without conduit, in electrical trays (approved by owner), and where otherwise shown on drawings, provided conductors are reasonably protected from mechanical and environmental damage.
I. Conductors run without conduit shall be approved, UL Listed, rated and labeled for Plenum use.
J. Secure wire and cable with approved supports in accordance with the referenced standards and the Authority Having Jurisdiction.
K. Provide cable supports at a minimum of 4-foot intervals.
L. Equipment and devices shall be installed on approved electrical back-boxes. Do not install equipment and devices directly on walls, ceilings or structural components without back- boxes.
M. Secure cables to cabinets, junction boxes, pull boxes and outlet boxes with approved cable clamps.
N. Independently support cables. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, mechanical piping, or mechanical ducts).
O. Support cable independently of junction boxes, pull boxes, fixtures, suspended ceiling T- bars, angle supports, and similar items.
P. Support cable using cable trays, D-brackets, support straps, support wires or other approved cable supports.
Q. Fasten cable supports to building structure and surfaces.
R. In shared electrical trays, open ducts, and other cable runs without conduit, separate and strap Access Control cable so that it is clearly distinguishable from all other cables.
S. Clearly mark security system cables at minimum intervals of every 10-feet. Marking shall be with a permanent, printed label, color-coded tag, or other distinguishing marking. Felt tip pen marking on the cable is not acceptable.
T. After installation, and before termination, wiring shall be checked and tested to insure there are no grounds, opens, or shorts on any conductors or shields. In addition, wiring between buildings or underground and all coax cables shall have insulation tested with a megohmmeter and a reading of greater than 20 megohms shall be required to successfully complete the test.
U. Run wires continuously from termination to termination without splices. Splices at junction box locations are not allowed.
V. Water-resistant protection shall be continuous throughout the cable in outdoor surface conduit, poles, in-slab pull-boxes, in-slab conduit, and underground conduit and pull-boxes, and in any areas subject to moisture and/or water infiltration.

1. Splices/Junctions: Provide water-proof protection of splices and junctions, in surface conduit and boxes, in-slab conduit and pull-boxes, underground conduit, and underground pull-boxes, to prevent the entry of moisture or water into cables, splices or connections.
2. Cable Entries: Provide water-blocking sealants at all conduit entries into pull- boxes, junction boxes, back-boxes, cabinets, etc., to prevent the entry of moisture or water into the conduit and cable system.

W. Labeling: Identify wire and cable clearly with permanent labels wrapped around the full circumference within one inch of each connection. Correlate the number designated on the associated Shop or Field Drawings. Assign wire or able designations consistently throughout a given system. Each wire or cable shall carry the same labeled designation over its entire run. Regardless of intermediate terminations.

X. Boxes: Provide a box loop for wire and cable routed through pull boxes or controller panels. Cable loops and bends shall not be at a radius less than that recommended by the manufacturer. Coordinate pull box size with the Division 26 Contractor as necessary to accommodate this requirement.

Y. Wire Lacing and Dressing: Dress, lace, tie or harness wire and cable vertically, horizontally and at right angles to the enclosure surfaces to prevent mechanical stress on electrical connections as required herein and in accordance with accepted professional practice. No wire or cable shall be supported by a connection point.

Z. Non-Coaxial Connections: Make non-coaxial connections and approved splices within terminal cabinets (except microphone or line level) to screw-type barrier blocks with insulated crimp- type spade lugs. Size all lugs properly to assure high electrical integrity. Connect only one (1) wire per spade lug and not more than two (2) lugs per screw terminal.

AA. Non-Coaxial splicing at device locations to equipment with wire leads shall be made with pre-approved wire Dolphin Connectors.

BB. Shielded Cables: Shielded cables shall be insulated. Do not permit shields to contact conduit, raceway, boxes, terminal cabinets or equipment enclosures. Tin terminated shield drain wires and insulate with heat shrinkable tubing.

CC. Coaxial Splices: Coaxial splices, if required and approved, shall be on plate mounted dual - barrel type insulated BNC connectors, secured in such a manner that no stress is placed upon the connector.

DD. Unacceptable Conditions: Correct any unacceptable wiring conditions immediately upon discovery, and upon receiving notice to correct.

EE. Wiring to provide all 120 VAC sources and points of connection to same shall be by the Electrical Contractor.

FF. All wiring, including low voltage power, voice, signal and data communication, shall be installed in approved metal raceway as required. All wiring, conduit and installation shall be in accordance with the latest edition of the National Electrical Code, especially article 725, with conduit fill requirements as though system wiring were 120VAC, (40% conduit fill) and the requirements of Division 26, Electrical Specifications. Up- size conduits from sizes shown on drawings, as necessary not to exceed 40% fill criteria. All conduit shall be ¾" minimum unless otherwise noted on the riser diagrams.

GG. Ensure cabling shield does not touch terminal connections. Provide "one-end" ground on all shields using drain wires at control panels, power supplies, or head end equipment, then to separate and dedicated RF ground via #8 AWG copper cable. Insulate shield at device end with shrink tubing to completely cover shield and drain wire.

HH. Where multiple devices are served by the same shielded cable, shield continuity shall be maintained and properly insulated to eliminate intermittent grounding. Do not bring shield grounds directly to a building electrical ground point of connection. Carefully follow manufacturer's instructions and advise Engineer accordingly. Shield grounds shall be treated as specified herein unless prohibited by manufacturers.

II. Lay out conduit and cable runs with Electrical and General Contractor prior to installation, and maintain 1'-0" clearance from parallel runs with 120VAC or larger voltage conduit and wiring.

Cross 120VAC or larger voltage conduit runs at 90° to reduce EMI and RF induction in security wiring.

JJ. All wires shall be color coded to provide separate identification of intrusion alarm signal, 12 VDC, 24 VAC, or ACS/IDS system data communication, lock power, video signal, VSS alarm input, zone expansion or relay board power and data bus or any other system function. Wires shall be similarly coded for each system serviced throughout the entire installation.

KK. All resistors shall be solder connected or double crimp connected to eliminate any additional circuit resistance. Wires connected to resistors shall be solder-tinned to insure positive solder connection or crimp connection. Resistors shall be insulated with shrink tubing extending a minimum of 1" either side of resistor. (Unless factory installed and potted as part of magnetic contact construction.)

LL. No intermediate cable splices are allowed without the specific written approval of the Security Consultant. Request clarification and approval prior to installation of any splices.

MM. All alarm circuits shall be tagged at the device end and field control panel end with alarm panel or zone addressing module hardware circuit terminal address numbers.

NN. Transformers and power supplies shall be identified, along with their cable, at both transformer and load fed end of cable.

OO. Each alarm device system cable shall be tagged at both the device and control panel end with the device type (i.e. door contact, motion detector, etc.).

PP. All 12VDC power circuits shall be tagged at each device and 12VDC power supply fused terminal strip with 12VDC panel and fused circuit number.

QQ. All power cables shall be tagged at the device end and power panel end with matching numbers.

RR. All wiring in panels shall be neatly dressed, run parallel wherever possible, and provided with adequate slack for future maintenance and service terminations.

SS. All "unused" wire conductors shall be insulated to eliminate shorts and grounds, tagged with their terminal points and identified as "spare" at each end with a unique spare cable tag identification system.

TT. Minor deviations (relocations) in wire runs to installed mounting locations may be required prior to final acceptance when site conditions affect the equipment's operation, performance, or purpose. Relocations which require only minimal work (plus or minus 15') and/or materials shall be made without additional cost or credit.

UU. The Contractor shall note that connection of alarm zone circuits to the ACS/IDS panels will require the installation of end-of-line resistors in each zone circuit. Locate as close to the device as possible to provide as much circuit supervision as possible. EOL resistors shall not be located at the panel for active security circuits. All unused zones shall have the end-of-line resistor mounted in the panel if manufacturers' requirements so dictate. Where end-of-line resistors are to be mounted at devices that are factory sealed and have factory configured wire leads, the resistor shall be spliced in-line with the leads as close to the device as possible (splices shall be soldered and covered with heat shrink tubing as specified elsewhere in these specifications).

VV. The Contractor shall install panel cover-operated tamper switches in each equipment enclosure, cabinet, housing, to actuate an alarm signal before access to equipment wiring within the enclosure is gained. Tamper switch mounting hardware shall be concealed so that the location of the switch cannot be visually detected from the exterior of the enclosure. These circuits shall be supervised.

WW. All wiring or cable shall be tested for, and be free of, opens and shorts. All wiring shall test free of grounds with the exception of circuits that are intended to be connected to the ground side of protective circuits.

XX. All wire and cables entering equipment cabinets and enclosures shall be grouped and tied inside the enclosures on 6-inch centers with self-locking nylon cable ties. All wiring shall be grouped in an orderly fashion. Under no circumstances is the use of adhesive tapes (electrical or other) permitted for either permanent or temporary ties or wire management.

YY. All stranded wiring that is connected to equipment that has terminal strips or screw lugs shall be terminated with either nylon insulated crimp-on spade lugs, equal to Thomas & Betts STA-KON fork tongue locking type or equivalent, sized for correct wire and screw sizes or shall be solid

bare wire attached to screw terminals. Where compression screws are used to cap wiring, wiring shall be tinned to eliminate destranding and consequent poor connection. Each spade lug or wire shall be marked with a self- sticking numbered wire marker and documented on the as-built wiring diagrams.

ZZ. All wiring that is connected to equipment with solder lug connectors shall terminate wire to lug in a solder joint. The solder joint, lug and any bare wire shall be covered with heat shrink tubing. Multi-conductor bare wire ends shall be soldered to prevent de-stranding.

AAA. Each wire and cable shall be clearly marked within each enclosure, junction box, or where termination is made. Wires and cables shall be marked with a clear, heat-shrink system such as “Shrink Mark” or equivalent, labeling system as manufactured by RayChem. Cable numbers shall be generated on a PC. Felt-tip “Sharpie” type pen markings are unacceptable. Marking documentation shall be included with the detailed wiring diagram to be provided to the Owner on completion of the installation as part of the As-Built documentation in the “Project Manuals”.

BBB. Wiring and cables that are installed shall maintain color coding from origination point to termination point. Where paired cable is used, the pairs in the cable shall be maintained in the run. Pairs shall not be separated to form different pairs than those in the original cable. Color coding shall be maintained within the system. Maintaining color coding applies to all type circuits in the system.

CCC. Review wiring type, scheme and tagging for all systems prior to installation, with factory/technical representatives. Advise the engineer of any required modifications prior to wire procurement and installation and obtain approval accordingly. It is the contractor’s responsibility to review the system’s wiring with the factory representatives and supply the cables which meet their requirements. Where heavier gauge cables are specified by the engineer and such provide enhanced performance reliability, durability or future capacity, they shall be used unless prohibited by the manufacturer.

DDD. Paralleling of multi-conductor cables to “create” a cable of larger wire gauge is prohibited, except at door frame power transfer hinges.

EEE. Wiring diagrams shall be provided in all signal and power panels along with cable schedules, in a clear plastic envelope, for future use in system maintenance and service.

FFF. Run electric lock power circuits so that each electrified locking door opening is wired on its own wire pair to a dedicated fused circuit in the lock power supply.

GGG. Connect no more than five (5) 12VDC security devices to a single pair of 12VDC power wires without the engineer’s approval. Terminate these 12VDC power circuits on a dedicated fused outlet in the 12VDC power supply

3.3 FIELD QUALITY CONTROL

A. Testing Agency: The Contractor shall engage a qualified testing agency to perform tests and inspections with the Owner and appointed project manager.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.

2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements.
3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least fourteen (14) days. Provide a minimum of ten (10) days notice of test schedule.
4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

E. Access Control System shall be considered defective if it does not pass tests and inspections.
F. Prepare test and inspection reports.

3.4 CLEANING

A. Remove rubbish and debris: Installation contractor is not allowed you use the onsite dumpster and is responsible to discard their own debris off site.
B. Clean installed items using methods and materials recommended in writing by manufacturer.
C. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 CLOSEOUT ACTIVITIES

A. See Division 01 – Closeout Submittals for Closeout Submittals.

3.6 PROTECTION

A. Protect installed system components from subsequent construction operations.

3.7 MAINTENANCE

A. See Division 01 – Execution and Closeout Requirements for additional requirements relating to maintenance service.
B. Adjustments:

1. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two (2) visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:

a. Check cable connections.
b. Check proper operation of access control devices.
c. Provide a written report of adjustments and recommendations.

C. Provide to Owner, at no extra cost, a separate maintenance contract for the service and maintenance of the Access Control System for One Year from date of Substantial Completion. Include a separate description of preventative maintenance, systematic examination, cleaning, inspection, and testing, with a detailed schedule.

D. Conduct site visit at least once every three months to perform inspection, testing, and preventative maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.
E. 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 the site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION 28 0500

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SECTION 28 0528
PATHWAYS FOR SECURITY SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1. "T" Drawings – Technology Plans

C. Related Sections:

1. Section 271500 – "Communication Horizontal"
2. Section 280500 – "Security Conductor Cables"
3. Section 281300 – "Access Controls"
4. Section 281600 – "Intrusion Detection"
5. Section 282300 – "Video Surveillance"

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Surface pathways.
7. Boxes, enclosures, and cabinets.
8. Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.
B. GRC: Galvanized rigid steel conduit.
C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
B. HPBS Submittals:

1. Product Data for Section 16a-38k-5(d): For solvent cements and adhesive primers, documentation including printed statement of VOC content.

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

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

1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.
C. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, equipment racks and their mounting provisions, including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Alpha Wire Company
4. Anamet Electrical, Inc.
5. Electri-Flex Company
6. O-Z/Gedney; a brand of EGS Electrical Group
7. Picoma Industries; Subsidiary of Mueller Water Products, Inc.
8. Republic Conduit
9. Robroy Industries
10. Southwire Company
11. Thomas & Betts Corporation
12. Western Tube and Conduit Corporation
13. Wheatland Tube Company; a division of John Maneely Company

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

C. GRC: Comply with ANSI C80.1 and UL 6.
D. ARC: Comply with ANSI C80.5 and UL 6A.
E. IMC: Comply with ANSI C80.6 and UL 1242.
F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.
H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

a. Material: Steel.
b. Type: Setscrew.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.
4. Arnco Corporation
5. CANTEX Inc.
6. CertainTeed Corp.
7. Condux International, Inc.
8. Electri-Flex Company
9. Kraloy
10. Lamson & Sessions; Carlon Electrical Products
11. Niedax-Kleinhuis USA, Inc.
12. RACO; a Hubbell company
13. Thomas & Betts Corporation

B. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

C. RNC: Type EPC-40-PVC complying with NEMA TC 2 and UL 651 unless otherwise indicated.
D. Rigid HDPE: Comply with UL 651A.
E. Continuous HDPE: Comply with UL 651B.
F. RTRC: Comply with UL 1684A and NEMA TC 14.
G. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

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

1. Alpha Wire Company.
2. Arnco Corporation.
3. Endot Industries Inc.
4. IPEX.
5. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible-type pathway, approved for plenum installation unless otherwise indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

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

1. Cooper B-Line, Inc.
2. Hoffman; a Pentair company
3. Mono-Systems, Inc.
4. Square D; a brand of Schneider Electric

B. Description: Sheet metal, complying with UL 870 and NEMA 250 and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
D. Wireway Covers: Screw-cover type unless otherwise indicated.
E. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

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

1. Allied Moulded Products, Inc.
2. Hoffman; a Pentair company
3. Lamson & Sessions; Carlon Electrical Products
4. Niedax-Kleinhuis USA, Inc.

B. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
F. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 SURFACE PATHWAYS

A. General Requirements for Surface Pathways:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Mono-Systems, Inc.

b. Niedax-Kleinhuis USA, Inc.
c. Panduit Corp
d. Wiremold/Legrand

C. Surface Nonmetallic Pathways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL-94 V-0 requirements for self-extinguishing characteristics.

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

a. Hubbell Incorporated; Wiring Device-Kellems Division
b. Lamson & Sessions; Carlon Electrical Products
c. Mono-Systems, Inc.
d. Panduit Corp.
e. Wiremold/Legrand

2.7 BOXES, ENCLOSURES, AND CABINETS

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

1. Adalet

B. Cooper Technologies Company; Cooper Crouse-Hinds

1. EGS/Appleton Electric
2. Erickson Electrical Equipment Company
3. Hoffman; a Pentair company
4. Hubbell Incorporated; Killark Division
5. Lamson & Sessions; Carlon Electrical Products
6. Milbank Manufacturing Co.
7. Molex; Woodhead Brand
8. Mono-Systems, Inc.
9. O-Z/Gedney; a brand of EGS Electrical Group
10. RACO; a Hubbell company
11. Robroy Industries
12. Spring City Electrical Manufacturing Company
13. Stahlin Non-Metallic Enclosures; a division of Robroy Industries
14. Thomas & Betts Corporation
15. Wiremold/Legrand

C. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-B.
2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

D. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
F. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
G. Metal Floor Boxes:

1. Material: Cast metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Nonmetallic Floor Boxes: Nonadjustable, rectangular.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
K. Device Box Dimensions: as specified within the Architectural drawings.
L. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, with continuous-hinge cover with flush latch unless otherwise indicated.

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

a. Material: Plastic.
b. Finished inside with radio-frequency-resistant paint.

3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

PART 3 EXECUTION

3.1 PATHWAY APPLICATION

A. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:

a. Loading dock.
b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
c. Mechanical rooms.
d. Gymnasiums.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT. Allow plenum cable in j-hooks or cable tray.
5. Damp or Wet Locations: GRC.
6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway.
7. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: Plenum-type, optical-fiber-cable pathway.
8. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

B. Minimum Pathway Size: ¾-inch trade size. Minimum size for optical-fiber cables is 1 inch.
C. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew or compression, cast-metal fittings. Comply with NEMA FB 2.10.

D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
E. Install surface pathways only where indicated on Drawings.
F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg.

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
C. Complete pathway installation before starting conductor installation.
D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
F. Install no more than the equivalent of two (2) 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
H. Support conduit within 12 inches of enclosures to which attached.
I. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to RNC, Type EPC-40-PVC before rising above floor.

J. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
L. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
N. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus ¼ turn more.
O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
P. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
Q. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.
R. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inch radius control at bend points.
3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

S. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. ¾-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
3. Install with a maximum of two (2) 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

T. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.
U. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

V. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
W. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
AA. Support boxes of three (3) gangs or more from more than one (1) side by spanning two (2) framing members or mounting on brackets specifically designed for the purpose.
BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
CC. Set metal floor boxes level and flush with finished floor surface.
DD. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 271000 "Structured Cabling."

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 28 0528

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SECTION 28 1300
ACCESS CONTROL SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. System Requirements
B. Access Control Field Devices
C. Access Control System

1.2 RELATED REQUIREMENTS

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.” OR Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Division 07 - Firestopping.
C. Division 08 - Door Hardware: Electrically operated door hardware, for interface with access control system.

    1. Includes door hardware with integral request to exit devices.

D. Division 11 - Electric Traction Elevators: For interface with access control system.
E. Division 14 - Hydraulic Elevators: For interface with access control system.
F. Division 26 - Grounding and Bonding for Electrical Systems.
G. Division 26 - Conduit for Electrical Systems.
H. Division 26 - Identification for Electrical Systems: Identification products and requirements.
I. Division 27 - Structured Cabling: Data cables for access control system IP network connections.
J. Division 28 - Video Surveillance: For interface with access control system.
K. Division 28 - Building Intrusion Detection: For interface with access control system.
L. Division 26 - Fire Detection Alarm: For interface with access control system.
M. Refer to the following construction documents for Data Room locations and device locations only.

    1. “T” Drawings – Technology Plans

N. Any apparatus, appliance, material, or work not shown on the Drawings but mentioned in the Specifications, or vice versa, and any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation, even if not particularly specified, shall be provided without additional expense. Coordinate with each system manufacturer to ensure all hardware, firmware, relays, or other necessary components are provided prior to bid submission.
O. All work of this Section to comply with the requirements of the Conditions of Contract, with all Specification Sections of Division 01 – General Requirements, with the Security Drawings, and with all other Contract Documents.
P. Refer to Division 26 of the Contract Documents, Electrical, for all Specifications governing the installation of raceway (conduit, EMT, cable trays, wire trough, etc.), system junction and pull

boxes, and device rough-in boxes, for all Security System work shown on the Security Drawings. Conduit, back box, and trough work to be provided by this Contractor.

Q. Refer to Division 26 of the Contract Documents, Electrical, for all work related to the interconnection of Security System equipment to 120 VAC power sources.

R. Refer to Division 09 of the Contract Documents, Finishes, for details relating to acoustical ceilings and gypsum board systems, floor finishes, painting, etc., for information pertinent to device and back box selection and installation.

S. Refer to Division 08 of the Contract Documents, Openings, for details relating to doors, door frames, windows, and window frames, for information pertinent to the selection of magnetic contact devices and their associated placement and installation, including back box selection and installation.

T. Refer to Division 08 of the Contract Documents, Openings, for details relating to door and door frame hardware and preparation, electrified lock power supplies, required coordination to accommodate these components and/or systems, lock voltage and current draw coordination, coordination of fail-safe electrified locks, and any other related equipment or requirements

U. Refer to Division 06, Wood, Plastics, Composites, and coordinate all desk locations and installation details with the Millwork Contractor.

V. Review all other Specification Sections as required to achieve complete inter- trade coordination.

1.3 DEFINITIONS

A. API: Application Programming Interface
B. AVI: Audio Video Interleave
C. CA: Certificate Authority
D. CAC: Common Access Card
E. CE: European Union Conformity
F. CPU: Central Processing Unit
G. CSV: Comma Separated Values
H. DNS: Domain Name Server
I. DSM: Door Status Monitor
J. DVR: Digital Video Recorder
K. EACS: Electronic Access Control System
L. FCC: Federal Communications Commission
M. FIPS: Federal Information Processing Standard
N. FIFO: First In – First Out
O. FTP: File Transfer Protocol
P. FRAC: First Responder Authentication Credential
Q. GB: Gigabyte
R. GSOC: Global Security Operations Center
S. GUI: Graphical User Interface
T. HA: High Availability
U. HTML: Hypertext Markup Language
V. 4, H.265: Video Compression Standards
W. I2C: Inter-Integrated Circuit
X. IEEE: Institute of Electrical and Electronics Engineers
Y. I/O: Input / Output
Z. IP: Internet Protocol
AA. IS: Integrated System
BB. JPEG: Joint Photographic Experts Group
CC. LAN: Local Area Network
DD. LDAP: Lightweight Directory Access Protocol
EE. MB: Megabyte
FF. MJPEG: Motion JPEG
GG. MSATA: Mini-Serial Advanced Technology Attachment

HH. MSP: Mobile Security Professional
II. MTBF: Mean-Time Between Failure
JJ. NAS: Network Attached Storage
KK. NAT: Network Address Translation
LL. NBAPI: NetBox Application Programming Interface
MM. NECA: National Electric Code Association
NN. NFPA: National Fire Protection Association
OO. NVR: Network Video Recorder
PP. ODBC: Open Database Connectivity
QQ. OS: Operating System
RR. OVID: Open Video Integration Driver
SS. PDF: Portable Document Format
TT. PIN: Personal Identification Number
UU. PIV: Personal Identity Verification
VV. PoE: Power over Ethernet
WW. PTZ: Pan-Tilt-Zoom
XX. RAID: Redundant Array of Independent Disks
YY. RAM: Random Access Memory
ZZ. REX: Request to Exit
AAA. RFID: Radio Frequency Identification
BBB. RoHS: Restriction of Hazardous Substances
CCC. ROM: Read Only Memory
DDD. RU: Rack Unit
EEE. SFTP: Secure File Transfer Protocol
FFF. SHA: Secure Hash Algorithm
GGG. SIO: Serial Input / Output
HHH. SLA: Sealed Lead-Acid
III. SMS: Security Management System or Short Message Service (text messaging)
JJJ. SSL: Secure Sockets Layer
KKK. SUSP: Software Upgrade and Support Plan
LLL. TCP: Transmission control protocol - connects hosts on the Internet
MMM. TIA: Telecommunications Industry Association
NNN. TLS: Transport Layer Security
OOO. TWIC: Transportation Worker Identification Credential
PPP. UI: User Interface
QQQ. UPS: Uninterruptible Power Supply
RRR. UTP: Unshielded Twisted Pair
SSS. VMS: Video Management System
TTT. WAN: Wide Area Network
UUU. Wi-Fi: Wireless Network
VVV. AS NECESSARY: Shall mean work which is required for completed construction, but is not necessarily shown or described in the Contract Documents.
WWW. AS REQUIRED: Shall mean work which is required for completed construction, but is not necessarily shown or described in the Contract Documents.
XXX. Substantial Completion: Shall mean that the project is sufficiently complete to be utilized for its intended use as stated in the body of this written specification.
YYY. Contractor/INTEGRATOR: Refers to the biding/installation Contractor responsible for furnishing and installation of all work indicated within this specification.

1.4 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. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
D. UL 294 - Access Control System Units; Current Edition, Including All Revisions.
E. UL 1076 - Proprietary Burglar Alarm Units and Systems; Current Edition, Including All Revisions.
F. System shall be RoHS (Restriction of Hazardous Substances) compliant and meet proposed amendments to the reduction of toxic substances in manufacturing in stated in the Environmental Design of Electrical Equipment Act (EDEE).
G. Installation shall comply with NECA 1-2010 “Standard Practice of Good Workmanship in Electrical Construction”
H. Installation shall comply with NEC/NFPA 70E “Standard for Electrical Safety in the Workplace”
I. Electronic data exchange between Video Surveillance System and the Access Control System shall comply with SIA TVAC
J. Installation shall comply with FCC CFR 47 Part 15 Class A “Telecommunications, Radio, Frequency, Digital Device Emission:
K. Installation shall comply with Federal, State, and Local Codes and Authority Having Jurisdiction (AHJ).
L. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other installers to provide suitable door hardware as required for both access control functionality and code compliance.
2. Coordinate the placement of readers with millwork, furniture, equipment, etc. installed under other sections or by others.
3. Coordinate the work with other installers to provide power for equipment at required locations.
4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meetings:

1. Conduct meeting with facility representative to review reader and equipment locations.
2. Conduct meeting with facility representative and other related equipment manufacturers to discuss access control system interface requirements.

C. Confidentiality of Documents

1. The project documents, consisting of all technical proposals, drawings, specifications, shop drawings, as-built drawings, manufacturer’s literature, etc., shall be considered proprietary information and are to be treated with complete confidentiality. Dissemination of any security system documentation to any party not considered “need-to-know” without a pre-defined and approved agreement will be considered a violation of the contract documents and all pursuant clauses regarding financial penalties, project termination, and/or legal prosecution will apply. The Contractor is to obtain a list of “need-to-know” parties from the Owner and/or Construction Manager.
2. Use of the Contract drawings and specifications is restricted to the original site for which they were prepared. Publication therefore is expressly limited to such use. Re-use, reproduction, storage by any medium or publication by any method in whole or in part is

prohibited. Visual contact with the Contract drawings and specifications constitutes prima facie evidence of the acceptance of these restrictions. Unlawful publication, dissemination, and use of these documents carry significant liability and the Owner maintains the right to legally pursue restitution and/or penalty for violation of these confidentiality conditions.

3. All documents marked “DO NOT DUPLICATE” are to be returned to the Construction Manager for proper disposal and handling upon completion of their relevant use.

1.6 SUBMITTALS

A. See Division 01 – Administrative Requirements for submittal procedures.

1.7 EVIDENCE OF QUALIFICATIONS FOR INSTALLER:

1. The Contractor shall be a bona fide security systems contractor, licensed by the State of Connecticut for the installation of the low voltage security and signal communication systems, and engaged in security system maintenance, service and contracting for at least the last five years.
2. The Contractor shall employ technicians who have been trained by the Manufacturer specified within this section to install the systems of this Manufacturer.
3. The contractor shall be a factory authorized stocking distributor of the manufacturer of the equipment included in the system so that immediate replacement parts can be made from inventory and service provided as needed on an emergency basis.
4. The Contractor shall submit with the bid a manufacturer’s certificate of acceptance of the qualifications of the Installing Contractor to install, test, maintain and repair the manufacturer’s equipment.
5. In order for the Security Consultant to verify that they meet the competency requirements of this specification, Contractors must submit the following information if so requested:

    a. Proof that the Contractor has installed, services and maintained similar security systems for a minimum of ten (10) years.
    b. Proof that the Contractor is a firm which currently and regularly installs, services and maintains security systems as a full time business.
    c. The names and qualifications of security system technicians that shall perform and supervise the work, and perform tests or adjustments on the systems and equipment. Qualifications shall include all schooling, training, and history of work experience.
    d. A list of four prior systems comparable to the one specified under this contract which were installed, serviced, and maintained satisfactorily by the Contractor for a minimum of one (1) year. Each system listed shall include the firm or owner, location, person to contact (with telephone number), date of installation and service period, and a brief description of the system and work performed on the system.

6. The Contractor shall submit any other information required by the Security Consultant to determine the competency of the Contractor. If this information is not submitted as requested, it shall be submitted within the time specified by the Architect after the bid opening. If the Contractor fails to submit the information in accordance with the Security Consultant’s request, the Contractor shall be declared non-responsive, and may be rejected to perform the work specified within this section.
7. Unit Prices:

    a. Contractor shall submit unit pricing, on the project Bid Form, stating the unit price for all materials, items, work and construction.

b. Contractor shall provide prices for the addition of, or the elimination of, the following components for the project by identifying the additive or deductive price for each. Prices shall include labor and materials to furnish and install, test, and integrate into the system, provide the specified documentation and as-built drawings and manuals, and required training. Where conduit and wire connections are required, include 100' of necessary cables, conduit, and interconnections. The Contractor acknowledges that should conditions make it necessary to revise the scope of the project, the following unit price itemization will serve as the basis for adjustments to the Contract Price.

1) Surface or Recess Mount Magnetic Door Contact $[_____]
2) Card Reader $[_____]
3) Access Controller $[_____]
4) Access Control Reader Module $[_____]
5) Door Related Release Button $[_____]
6) Dress Button $[_____]
7) Security Device Power Supply $[_____]
8) Electric Local Power Supply $[_____]

B. Design Data: Standby battery/UPS Calculations
C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instruction for storage, handling, protection, examination, preparation, installation, and operation of product.
D. Manufacturer's detailed field-testing procedures.
E. Maintenance contracts.
F. Product Data: Provide details and technical specifications for each product indicated. Include physical dimensions, features, performance, electrical characteristics, ratings, software versions, and operating system details.
G. Shop Drawings:

1. General: General: Bid documents, including drawings, details and specifications are considered conceptual in nature, and provide direction on products and project requirements. Contractor is given a choice of methods that may be incorporated into the system. These choices may affect the overall design, configuration and installation of the proposed system.
2. Contractor Responsibility: Prepare and submit shop drawings, rendered in the latest AutoCAD DWG file format, which show details of all work to ensure proper installation of the work using those materials and equipment specified or allowed under the approved plans and specifications. A complete Shop Drawing submittal drawing package shall consist of Drawings, Equipment Data Sheet Submittals, and an Acceptance Testing Plan.
3. Completeness: The Equipment Submittals, Acceptance Testing Plan, and the Shop Drawings should be submitted as a complete and contiguous package. Partial or unmarked submittals will not be accepted for review.
4. Scheduling: A schedule of shop drawing submissions shall be submitted for the Architect and Owner's Representative review on a form acceptable to the Architect within ten (10) days after award of the Contract. The schedule of shop drawing submissions shall include as a minimum, but not limited to the requirements stated herein.
5. Requirements: Provide the following information complete, and in the manner described herein:

a. Hardware, Application Software, and Network Requirements: A system description including analysis and calculations used in sizing equipment required by the security systems. The description shall show how the equipment will operate as a system to

meet the performance requirements of the systems. The following information shall be supplied as a minimum:

1) Server(s) processor(s), disk space and memory size
2) Workstation(s) processor(s), disk space and memory size
3) Description of facility (field) control equipment (Controllers/Field Panels, Models) and their configuration
4) Operating System(s) Software, where software is provided or upgraded
5) Application Software, with Optional and Custom Software Modules supplied in this project
6) Integration Schemes: Proposed connectivity, software, development requirements, and SDK information, for inter-system communication.
7) Network bandwidth and reliability requirements
8) Number and location of LAN ports required
9) Other specific network requirements, preferences, and constraints
10) Backup/archive system size and configuration
11) Start-up operations
12) System power requirements and Uninterruptible Power Supply (UPS) sizing
13) Device/Component environmental requirements (cooling and/or heating parameters)

b. Shop Drawings: Shop Drawings shall be numbered consecutively and shall accurately and distinctly present the following information:

1) Title Sheet
2) Floor Plans: Showing devices, pull boxes, cabinets, conduits and conductors in their proposed locations with device numbering scheme.
3) Riser Diagram: Showing all conduit relationships between devices shown on the Floor Plans. Show all power sources.
4) Single-Line/Block Diagrams: Show signal relationships of controls and devices within the system.
5) Custom Assembly Diagrams: For each custom assembly such as Access Control Terminal Cabinets, receptacle assemblies, or door control panels, provide an assembly drawing illustrating the appearance of the assembled device. Include dimensions, assembly components, and functional attributes (momentary or alternate action switch, lens color, panel finish)
6) Component Connection Diagrams

    (a) For each equipment component such as a computer, video switcher, camera or video recorder, show the rear elevation of the device and all connectors/terminations as a pictorial.
    (b) Show the wire designations on connectors. Typical wiring detail where multiple of same device is provided.
    (c) Show a schedule of the wire colors connected to the pins on each device connector.

c. Equipment Wiring Diagrams

1) Show a pictorial illustration of each equipment enclosure and/or terminal cabinet, including terminals, components and wiring devices.
2) Show the device nomenclature exactly as shown on the single line diagrams.

3) Terminations: Show every termination and terminating cable, with applicable cable and wire numbers matching the single line diagrams.

   (a) Every termination in the system must be documented.
   (b) Termination information may be rendered as a wiring list(s), if properly coordinated with, and referenced to, typical component and single-line diagrams. Otherwise, the Shop Drawings shall show a pictorial of every component in the system, with its terminations.

4) Show wire colors for each terminal.
5) For each wire exiting the enclosure, show the destination of the wire by floor, room number and the drawing number of the panel where the wire terminates.
6) Provide working dimensions and erection dimensions.
7) Arrangements and sectional views
8) Necessary details, including complete information for making connections between work under this Contract, existing work, and work under other Contracts.
9) Stock or standard drawings will not be accepted for review unless full identification and supplementary information is shown thereon in ink or typewritten form.
10) Duplicate of design drawings may be used where each sheet is modified to reflect contractor coordination, specific requirements of the project and multi discipline conditions.
11) Each Drawing or page shall include:

   (a) Project name, Project Number and descriptions.
   (b) Submittal date and space for revision dates.
   (c) Identification of equipment, product or material.
   (d) Name of Contractor and Subcontractor.
   (e) Name of Supplier and Manufacturer.
   (f) Relation to adjacent structure of material.
   (g) Physical dimensions clearly identified.
   (h) ASTM and Specifications references.
   (i) Identification of deviations from the Contract Documents.
   (j) Contractor's stamp, initialed or signed, dated and certifying to review of submittal, certification of field measurements and compliance with Contract.
   (k) Location at which the equipment or materials are to be installed. Location shall mean both physical location and location relative to other connected or attached material.

d. Equipment Submittals

1) Provide a Title Page, with project name, Contractor’s name and address, contact information, date of submission, and submission revision number.
2) Provide a Parts List, for proposed equipment, materials, components and devices, listing the following information for each line item:

   (a) The system type
   (b) Model number
   (c) Specification sheet page reference

3) Provide Manufacturers Specification Sheet with descriptive information for equipment, materials, components and devices. Number each page, to correspond with the Parts List.
4) Clearly delineate (with highlighter, arrow, or underline) on each specification sheet, specific model numbers, options and configurations being proposed for this project.
5) Indicate kinds of materials and finishes for equipment where more than one option is presented.

e. Acceptance Testing Plan

1) Submit a written document detailing the test procedures to be followed in evaluating and proving the installed system(s).
2) Provide a sample of the test forms to be used for each system and for each component of each system.
3) Include all tests required by the equipment manufacturer and by this Specification

f. Spare Parts List: Submit a list of recommended spare parts for Owner's review & approval and/or amending. Spare parts shall comprise a minimum of 5% or minimum of 2 each of field devices, device termination boards and a minimum of 1 system controller boards.

g. Training Program

1) Submit a training program 10 working days prior to scheduled training to be followed in training key employees in the operation and maintenance of the installed system at the project site. The proposed training program shall be designed to provide a level of basic competence with the system for selected personnel. These selected personnel shall then be expected to train other personnel as required, utilizing the training that they have been given and the body of training documentation provided by Contractor. This plan shall comply with the requirements stated in the "Training" section, of these Specifications, all stated hours of which shall be considered to be classroom hours.
2) Submit a curriculum to account for, and relate, each subject to actual training time. All required hours shall be accounted for in this curriculum.
3) The training plan shall cover the overall system, each individual system, each subsystem, and each component. The plan shall also cover procedures for database management, normal operations, and failure modes with response procedures for each failure. Each procedural item must be applied to each equipment level.

h. Incomplete or unchecked submittals which do not contain complete data on the work and full information on related matters will be returned for correction.

i. Verification: The contractor shall check and acknowledge all shop drawings and shall place his signature on all shop drawings submitted for approval. Contractor's signature shall constitute a representation that all quantities, dimensions, field construction criteria, materials, catalog numbers, performance criteria and similar data have been verified and that, in his opinion, the submittal fully meets the requirements of the Contract Documents.

j. Timeliness: The Contractor shall schedule, prepare and submit a complete shop drawing assembly in accordance with a time-table that will allow his suppliers and manufacturers sufficient time to fabricate, manufacture, inspect test and deliver their

respective products to the project site in a timely manner so as to not delay the complete performance of the work.

k. Departure from Contract Requirements: If shop drawings show departures from the Contract requirements, the Contractor shall make specific mention thereof in his letter of transmittal, otherwise review of such submittals shall not constitute review of the departure. Review of the drawings shall constitute review of the specific subject matter for which the drawings were submitted and not of any other structure, materials, equipment, or apparatus shown on the drawings.

l. Contractor Responsibility: The review of shop drawings will be general and shall not relieve the Contractor of responsibility for the accuracy of such drawings, nor for the proper fitting and construction of the work, nor for the furnishing of materials or work required by the Contract. No construction called for by shop drawings shall be initiated until such drawings have been reviewed and approved.

m. Shop Drawing Submittal Review: The procedure in seeking review of the shop drawings shall be as follows:

1) The Contractor shall submit four (4) complete sets and/or electronic PDFs of shop drawings with equipment submittals and other descriptive data with one copy of a letter of transmittal to the Architect for review thirty (30) working days after award of the contract. The letter of transmittal shall contain the project name, DCAMM's Project Number, the name of the Contractor, the list of drawings submitted including numbers and titles, requests for any review of departures from the contract requirements and any other pertinent information. Drawings submitted for review shall be full-sized and included with the equipment submittals.
2) Drawings or descriptive data will be stamped "Reviewed", "Furnish as Corrected", "Revise and Resubmit", "Rejected" or 'Submit Specific Item' and one copy with a Letter of Transmittal will be transmitted to the Contractor with the return of submitted documents.
3) If a shop drawing or data is stamped "Reviewed" or "Furnish as Corrected", no additional submittal is required for that shop drawing.
4) If a shop drawing or data is stamped "Revise and Resubmit" or "Rejected", the Contractor shall make the necessary corrections and resubmit the documents as required above. The letter transmitting corrected documents shall indicate that the documents are re-submittals.
5) The Contractor shall revise and resubmit the shop drawing as required, until they are stamped either "Reviewed" or "Furnish as Corrected."

H. Equipment and Software List: Include every piece of equipment and software by product/model name and/or number, manufacturer, serial number, revision number, location, and date of original installation. If factory and/or bench testing regimens are required by the project plan, add pretesting record of each piece of equipment and software, listing name of person testing, date of test, and adjustments made.

I. CE and FCC Compliance Certificates:

J. Field quality-control reports

K. Current Specified Manufacturer Integrator Certification Letter

L. Current Specified Manufacturer Training Certificates (listing expiration dates) for Two technicians from the supporting office

M. Warranty: Software support and warranty information for all components, including Service Level Agreement (SLA) details, and duration of agreement from date of system acceptance by Owner. Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

N. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

O. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.
2. General: The Contractor is responsible for providing accurate drawings and equipment manuals describing and depicting the systems as they are actually installed and operated.
3. Phase One: Notwithstanding requirements specified elsewhere, submit the following labeled as the "Operating and Maintenance Manual" within thirty (30) days after Final Acceptance of the Installation:

a. Record Drawings: Submit two (2) copies of revised versions of drawings as submitted in the "Shop and Field" and "Equipment Wiring Diagrams" Submittals showing actual device locations, conduit routing, wiring and relationships as they were constructed. Include nomenclature showing as-built wire designations and colors. Drawings shall include room numbers coinciding with Owner space planning numbering. Drawings shall be submitted in electronic editable AutoCAD files, in ".dwg" format, on CD or DVD disks.
b. Manuals: Submit two (2) copies of each of the following materials in bound manuals, or electronic PDF copies on CD/DVD discs, with labeled dividers:

1) A final Bill of Material for each system.
2) Equipment Instruction Manuals: Complete, project specific comprehensive instructions for the operation of devices and equipment provided as part of this work.
3) Manufacturers Instruction Manuals: Specification sheets, brochures, Operation Manuals and service sheets published by the manufacturers of the components, devices and equipment provided.
4) Include information for testing, repair, troubleshooting, assembly, disassembly and recommended maintenance intervals.
5) Provide a replacement parts list with current prices. Include list of recommended spare parts, tools, and instruments for testing and maintenance purpose.
6) Performance, Test and Adjustment Data: Comprehensive documentation of performance verification according to parameters specified herein.
7) Warranties: Provide an executed copy of the Warranty Agreement and copies of all manufacturers' Warranty Registration papers as described herein.

1.8 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70.
2. NFPA 101 (Life Safety Code).
3. The requirement of the local authorities having jurisdiction.
4. Applicable TIA/EIA standards.

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. Installer qualifications: company specializing in performing the work of this section with minimum three years documented experience with access control systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer's representative.

    1. Contract maintenance office located within 100 miles (160km) of project site.

E. Maintenance contractor qualifications: same entity as installer.
F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities jurisdiction.
G. The requirements of the State Building Code and local regulations establish the minimum acceptable quality of workmanship and materials, and all work shall conform thereto unless more stringent requirements are indicated or specified herein.
H. All work shall comply with the latest editions of the codes as referenced herein.
I. Follow manufacturer's directions for articles furnished, in addition to directions shown on drawings or specified herein.
J. Protect all work, materials, and equipment from damage during process of work. Replace all damaged or defective work, materials and equipment without additional cost to DCAMM.
K. All equipment and materials for permanent installation shall be the products of recognized manufacturers and shall be new.
L. Equipment and materials shall:

    1. Where normally subject to Underwriters Laboratory Inc. listing or labeling services, be so listed or labeled.
    2. Be without blemish or defect.
    3. Not be used for temporary purposes.
    4. Be in accordance with the latest applicable NEMA standards.
    5. Be products which will meet with the acceptance of all authorities having jurisdiction over the work. Where such acceptance is contingent upon having the products examined, tested and certified by Underwriters or another recognized testing laboratory, the product shall be so examined, tested and certified.

M. Except for conduit, conduit fittings, outlet boxes, wire and cable, all items of equipment or material of one generic type shall be the product of one manufacturer throughout.
N. For items which are to be installed but not purchased as part of the electrical work, the electrical work shall include:

    1. The coordination of their delivery.
    2. Their unloading from delivery trucks driven into any point on the property line at grade level.
    3. Their safe handling and field storage up to the time of permanent placement in the project.
    4. The correction of any damage, defacement or corrosion to which they may have been subjected. Replacement, if necessary, shall be coordinated with Contractor who originally purchased the item.
    5. Their field make up and internal wiring as may be necessary for their proper operation.
    6. Their mounting in place including the purchase and installation of all dunnage, supporting members, and fastenings necessary to adapt them to architectural and structural conditions.
    7. Their connection to building wiring including the purchase and installation of all termination junction boxes necessary to adapt and connect them to this wiring. Included also shall be the purchase and installation of any substitute lugs or other wiring terminations as may be necessary to adapt their terminals to the building wiring as called for and to the connection methods set forth in these specifications.

O. Items which are to be installed but not purchased as part of the electric work shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the electric work will be considered only if presented in writing within one week of the date of delivery to the project of the items in question. The work includes all procedures, regardless of how extensive, necessary to put into satisfactory operation, all items for which no claims have been submitted as outlined above.
P. Seismic Performance: Provide equipment capable of withstanding the effects of earthquake motions determined according to ASCE/SEI 7 and current building codes for the state of CT.
Q. The term “withstand” means “the system(s) will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event.”

1.9 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Interior, Controlled Environment: System components installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F (2 to 50 deg C) dry bulb and twenty to ninety percent (20-90%) relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
2. Interior, Uncontrolled Environment: System components installed in non- temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and twenty to ninety percent (20-90%) relative humidity, noncondensing. Use NEMA 250, Type 3R enclosures.
3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and twenty to ninety percent (20-90%) relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick. Use sufficiently rated NEMA 250 enclosures.
4. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
5. Corrosive Environment: System components subject to corrosive fumes, vapors, and wind-driven salt spray in coastal zones. Use sufficiently rated NEMA 250 enclosures.
6. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.10 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.

1.11 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.12 WARRANTY

A. See Division 01 – Closeout Submittals for additional warranty requirements.
B. The Integrator guarantees the Systems to be installed under this specification to be free from any defects in workmanship and materials for a period of one (1) year from the date of final completion/acceptance of the project by the Owner as evidenced by the date of final payment for the work. The Contractor shall promptly and at their own expense remedy any defects in the work and pay for any damage to other work resulting thereof, which shall appear during the period of time covered by this guarantee. Neither the final certificate of payment nor any provisions in this Agreement shall constitute an acceptance of work not done in accordance with this specification or relieve the Contractor of liability with respect to any expressed warranties or guarantees or responsibility for faulty materials or workmanship.
C. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of equipment related to the Access Control System, and control-station equipment that fail in materials or workmanship within specified warranty period.

    1. Warranty Period: The standard manufacturer's warranty shall apply or a minimum of a one (1) year warranty from the date of Substantial Completion.

D. The Integrator shall provide all services required to maintain the system in an operational state as specified by the manufacturer for a period of one (1) year after acceptance.
E. Service response shall be within twelve (12) hours of the initial request for service and shall be provided twenty-four (24) hours per day, seven (7) days per week and three hundred sixty-five (365) days per year.
F. Contractor shall include, as part of this warranty, a program for maintenance for each integrated system.

    1. Provide details of coverage, preventive maintenance schedules, exclusions and service rates for all billable time and travel charges.
    2. Maintenance shall include two (2) semi-annual inspections and tests to verify the intended operation of the security system(s). System testing shall include but not be limited to the testing of all devises, fault modes and batteries. A detailed test report indicating these results and any corrective measures shall be furnished to the owner.

G. The Contractor shall provide software and firmware upgrades as required and available to the Owner.
H. Submit manufacturer's standard warranties.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. Furnish and install Access Control System consisting of required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
B. The awarded contractor of this section shall furnish and install a network access controlled system into this facility using electronic security devices. This integrated access control system shall incorporate all devices necessary to achieve the specified system, all associated monitoring and recording software, hardware, configuration, testing and training.
C. The contractor awarded this project must include the following licenses and configuration:

1. Access Control Manufacturer licenses for each camera on the Specified VMS system
2. Input / Output panels, and network nodes for all access-controlled doors, all door position switches, all duress & lockdown buttons, and all security strobes.
3. Access Control Manufacturer Licenses for integration with the Specified Intrusion Detection System.
4. Threat Level, Lockdown button configuration, and Day alarm configuration.
5. Alarm and notification configuration through the Specified Access Control User Interface GUI.

D. This Access Control System described within this specification shall be fully integrated with the Video Surveillance, Intrusion Detection, Public Address, and Fire Alarm System.
E. All installation, peripheral devices, required licensing and configurations are required as part of this specification to establish a coherent, functional system as described within this bid package.
F. Security control and network cabling to/from the equipment rooms to the controlled doors, as described within the documents shall be furnished and installed by the contractor awarded this project.
G. Any and all additional interconnection cabling required for a functional system shall be furnished and installed by the contractor awarded this portion of work.
H. Final terminations to all devices are required by the Contractor awarded this Section.
I. The Contractor awarded this Section shall furnish and install a complete integrated security system and all associated, terminations, supporting devices, configuration of system, testing and training in accordance with this Bid package.
J. This specification is used to identify the requirements for an integrated access control system. The operator workstation(s) shall be used for database programming and storage of historical events and as a User interface with the Video Surveillance System.
K. This system shall be integrated with the building's fire alarm system for proper activation of "fail-secure" locking mechanisms.
L. All interconnections required to the fire alarm system shall be terminated by the fire alarm installers and shall be coordinated with the contractor awarded this portion of work.
M. All system configuration(s) shall be included to attain a fully functional system and shall be within the Scope of work of the awarded contractor of this Bid package. This configuration shall include but not be limited to the following:

1. Configuration of all controlled doors and devices.
2. Configuration of all cameras shall be managed from the Access Control Platform
3. Configuration of LAN switches – Active Electronics as required.
4. Configuration of Access Control platform shall allow for Web access into the Access Control and Video Surveillance systems from all schools and via an internet connection which shall VPN into the owner's network.
5. Configuration of the Lockdown / Duress / Emergency buttons, as directed by the Security Consultant, Police Department, and Owner.
6. Configuration of the Access Control, Intrusion Detection, and Video Surveillance integration.
7. Configuration of the Day Alarm system, which will notify users of a propped or opened door equipped with door position switches, as directed by the security consultant and Owner.

N. Environmental Conditions: System(s) shall withstand the environmental conditions without mechanical or electrical failure, damage or degradation of its operating capacity Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Interior, Controlled Environment: System components installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F (2 to 50 deg C) dry bulb and twenty to ninety percent (20-90%) relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
2. Interior, Uncontrolled Environment: System components installed in non- temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and twenty to ninety percent (20-90%) relative humidity, noncondensing. Use NEMA 250, Type 3R enclosures.
3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and twenty to ninety percent (20-90%) relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick. Use sufficiently rated NEMA 250 enclosures.
4. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
5. Corrosive Environment: System components subject to corrosive fumes, vapors, and wind-driven salt spray in coastal zones. Use sufficiently rated NEMA 250 enclosures.
6. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

2.2 ACCESS CONTROL FIELD DEVICES

A. Access Control Server

1. The access control server shall be a Wall Mounted LenelS2 Extreme, wall mounted server.
2. Alternates shall not be accepted.
3. The server shall be sized for the quantity of access controlled doors shown on the security drawings plus 20% headroom.

B. Wall Mounted Access Control Security Panel:

1. S2-NN-E2R-WM

a. QTY (A/R)

C. Access Control Application Blade:

1. S2-ACM

a. QTY (A/R)

D. Relayed Output Application Blade:

1. S2-OUTP

a. QTY (A/R)

E. Supervised Input Application Blade:

1. S2-INPT

a. QTY (A/R)

2.3 REQUIRED LICENSES:

A. Milestone Integration:

1. S2-VMS-B-MS

a. QTY (A/R)

2. S2-VMS-C-MS

a. QTY (A/R)

B. Elevator license and software features A/R to accommodate all elevator card readers shown on the security drawings

C. Magic Monitor Bricks

1. S2-MMB

a. QTY (1) per Security Spot Monitor or CPU

D. Proximity Readers:

1. The selected manufacturer shall be HID – USA in 15370 Barranca Pkwy, Irvine, CA. Other manufacturers will be considered, providing equipment meets or exceeds the quality and functionality specified.
2. The selected model shall be:
3. HID, RP40, Wall-mounted multiCLASS SE Reader

a. HID, RP15, Wall-Mounted Mullion Mount multiCLASS SE Reader

4. Features:

a. Accepts 5 to 16 volts, meeting most voltage requirements.
b. Available with Wiegand or Clock-and-Data interface.
c. Allows easy upgrade from magstripe to a proximity reader; no rewiring or pulling of new cable required.
d. Offers high reliability, consistent read-range and low power consumption in an easy-to-install package.
e. Mounts directly onto metal with no change in read range performance.
f. Provides multicolor LED, compatibility with all standard access control systems and internal or host control of LED and beeper.

g. Includes multilingual installation manual.

5. Specifications:

a. Typical Maximum* Read Range

1) ProxCard® II card – up to 5.5 inches
2) ISOProx® II card – up to 5 inches

b. DuoProx® II card – up to 5 inches

1) Smart ISOProx®/DuoProx® cards – up to 5 inches
2) Proximity & MIFARE® card – up to 5 inches
3) ProxCard® Plus card – up to 2 inches
4) ProxKey® II keyfob – up to 2 inches
5) MicroProx® Tag – up to 2.5 inches
6) *Depending on local installation conditions.

c. Dimensions:

1) inches x 1.7 inches x 1.0 inch

d. Material:

1) Polycarbonate UL 94

e. Power Supply:

1) Standard MiniProx: 5-16 VDC
2) Loc. MiniProx: 5-16 VDC
3) Linear power supplies are recommended.

f. Current Requirements:

1) Max Average 30 mA
2) Typ Peak: 75 mA

g. Operating Temperature:

1) -22° to 150° F (-30° to 65° C)

h. Operating Humidity:

1) 0-95% relative humidity non-condensing

i. Weight:

1) With Terminal Strip: 3.5 oz.
2) With Pigtail: 3.8 oz.
3) Loc. MiniProx: 3.8 oz.

j. Transmit Frequency:

1) 125 kHz

k. Excite Frequency:

1) 125 kHz

l. Cable Distance:

1) Wiegand Interface: 500 feet
2) Clock-and-Data Interface: 50 feet
3) Recommended cable is ALPHA 1295 (22 AWG) 5 conductor
4) Minimum stranded with overall shield or equivalent. Additional conductors may be required for LED or beeper control.

m. Environmental:

1) IP55

n. Certifications:

1) UL294/cUL (US), FCC Certification (US), IC (Canada), CE (EU),
2) C-tick (Australia, New Zealand),
3) SRRC (China), MIC (Korea), NCC (Taiwan), MIC (Japan), iDA
4) (Singapore), RoHS

E. Request to Exit Sensor (REX / RTE):

1. Coordinate with the door hardware vendor and use the Provided Exit Request Touch Bar or Integral Lock Signal Switch, where specified in Division 08.
2. Where integral exit request touch bar is not specified, furnish an install the following:

a. Manufacturer:

1) BOSCH

(a) #DS160
(b) Approved Equivalent

F. Door Position Switches (Door Contacts):

1. All Door Position Switches shall be Double Pole-Double Throw (DPDT).
2. Door position switches shall be installed by the Contractor. The Contractor shall align, prepare, and fabricate doors and frames to accept specified door position switches. The Contractor shall be responsible for coordinating the installation, so systems and hardware operate as specified. Door Position Switches will be installed at the top of the door in the first instance. If unable to install on top, then side installation on the handle side is acceptable.
3. Surface Mounted Door Switch: DPDT sensor. Interlogix or approved equal. Surface Mounted Magnetic Switch with armored cable. Route armored cable to junction box and permanently secure to box with clamp or set-screws. Use only where flush-mounted devices cannot be installed.
4. Non-fire rated Doors, Flush Mount:

    a. Interlogix Model 1076C-W or approved equivalent Concealed Magnetic Door Switch.

5. Fire Rated Doors:

    a. General: Contractor shall coordinate access control hardware equipment and installation so as to maintain the Fire Rating of each specific door to the satisfaction of the Local Authority Having Jurisdiction.

G. Lockdown Button:

1. The selected model shall be: Safety Technologies Inc, #SS-2000 or an Approved Equivalent

    a. The lock down button shall be green and labeled “LOCKDOWN”
    b. The lockdown button shall have a key-to-reset function
    c. Include plastic cover – STI #6518

2. Lock-down buttons must be configured to Owner requirements. Minimally, these buttons will have to interface with the Access Control System, Intrusion Detection System, Public Address System and Video Surveillance System.
3. Lock Down buttons shall automatically release fire-alarm hold-open doors.
4. Lock Down buttons shall cause the security strobes to activate. Coordinate configuration and functionality with Security Consultant and Owner.
5. Lockdown shall send emails and text messages to up to 50 users.
6. Lockdown shall notify the Magic Monitor Bricks of an event.
7. Lockdown shall signal a pre-recorded message over the public address system. Coordinate message with public address integrator.
8. Lockdown shall dial-out to the central monitoring company, through the Honeywell intrusion detection panel.

H. Panic / Duress Button

1. The selected model shall be: Sentrol UL Rated #3050 or an Approved S2 equivalent. Include bi-color latching LED and single pole, double throw contacts.
2. Panic / Duress buttons must be configured to Owner requirements. Coordinate configuration and functionality with Security Consultant and Owner.

I. Security Strobe Lights:

1. The selected model shall be:

a. Talkaphone #ETP-EL12/24 or approved equal.
b. Contractor shall demonstrate that lamps are visible in direct sunlight prior to final installation and approval.
c. Include low voltage power supplies.
d. Lights shall be controlled through outputs of the Access Control Panel. Coordinate configuration and functionality with Security Consultant and Owner.

J. Door Release Buttons:

1. The selected model shall be:

a. Dortronics #H276-HD29 or an Approved S2 equivalent
b. The door release button shall be engraved with the label “ASSOCIATED DOOR # Push to Release”
c. The door release button shall be mounted to FSR #DSKB_385 Single Gang Table Box.

K. Access Control Source Power:

1. Derive primary Access Control 120VAC power from a designated power source within the telecommunication room, as shown on the T & Y drawings.
2. Power cable shall be protected by conduit.
3. Transformer shall be installed in locked cabinets, protected by tamper switches. Plug-in transformers which are not protected by locked cabinets are not acceptable.
4. Serve all Low Voltage powered devices within the Access Control Cabinet from the Electronics Power Supply.
5. Provide barriers as necessary to separate Class 1 from Class II power.

L. Access Control System Source Power Supplies and Batteries:

1. Furnish and Install Altronix UL Listed Class II power supplies or approved equivalent.
2. Serve all low voltage powered devices within the Access Control Enclosure from the Electronics Power Supply.
3. Capacity: The power supply shall be capable of powering a minimum of 125 percent of the load required at the time of acceptance (25% spare capacity).
4. Power Monitoring: The system shall monitor the loss and restoration of power at the Access Control Panel of both primary and secondary loss of power. Loss and restoration of power shall be displayed at the console, but shall not require resetting the system.
5. Battery Back-up: Provide battery back-up to retain functions of all electronics for a period of four (4) hours upon loss of 120VAC power.

M. Lock Power Supply (LPS)

1. Provide Altronix, UL Listed Class II power supplies within a ventilated, locked, cabinet within the telecommunication rooms as noted on the T & Y drawings, or as otherwise required, to affect proper system performance. Cabinet shall be equipped with a tamper

switch, which shall be connected to the Access Control System to provide a supervisory alarm. Power supply shall include separate terminals for each door lock. Power supply voltage shall be required by the hardware supplied locks.

2. Capacity: The power supply shall be capable of powering 200 percent of the load required at the time of acceptance (100% spare capacity).
3. Power Monitoring: The system shall monitor the loss and restoration of power at the Access Control Cabinet. Restoration of power shall be displayed at the console but shall not require resetting the system.
4. Battery Back-Up: Power supplies shall be equipped with integral battery recharging circuits and batteries. If a separate cabinet is used for batteries, the cabinet shall be locked and provided with a tamper switch connected to the Access Control System.

    a. Fail Safe Door Locks: Provide four (4) hours of battery backup for Low-Voltage electrified door hardware.
    b. Fail-Secure Door Locks: Provide battery backup enough to operate fail-secure door locks 100 times per hour, for four (4) hours.

5. Power supply output may be connected to remove UL-approved distribution board of the same manufacturer mounted within the Access Control Cabinet.
6. Provide a Fire Alarm Interface Relay to interface the LPS to the Access Control system and Fire Alarm System as shown on the contract drawings.
7. Transformers shall be installed in locked cabinets, protected by tamper switches. Plug-in transformers which are not protected by locked cabinets are not acceptable.

N. Auto Door Actuator Interface Relay: Furnish and install Dayton Model 5YR20N, or equal, with compatible relay base, at automated doors to ensure the Access Control System approved the Credential / Push Plate before actuator motor is engaged.

O. Provide IDEC RTE series interval timer, or equal, for interface with motorized door Push Plates and the Automated Door Operator. This will be used to provide a functional time extension fot he interaction of between the Access Control system and the Automated Door Hardware, to avoid damage and prevent unwanted alarms.

1. Unit shall be UL listed and operate on 24VDC.
2. Unit shall mount to UL listed relay socket.
3. Unit shall mount within the door operator housing.

P. Access Control Cabinet:

1. System controllers and field control boards serving a given area shall be installed inside Access Control Cabinets. No controller or control module shall be mounted independently of the cabinet and its power supplies. Refer to the drawings and the following descriptions for details on the Access Control Cabinet construction.

Q. Provide Access Control Cabinets as described below, located in the telecommunication rooms where the access control cabling terminates, per the T & Y Drawings, to house all equipment. Each access control cabinet shall contain the following equipment to support the current and future alarm initiating and controlled devices to be connected to the Access Control System:

    a. Access Control Cabinet:

1) Indoor: NEMA 2, hinged, locking cabinet by Access Control Manufacturer, Hoffman, or approved equal, sized to fit contents. Lock shall be coordinated with the Owner allowing replacement by the Owner.
2) Outdoor: Stainless steel, NEMA 4X, hinged locking handle cabinet by Access Control Manufacturer, Hoffman, or approved equal, sized to fit contents.
3) Provide door tamper switch and wire into alarm input for each Access Control Cabinet.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that ratings and configurations of system components are consisted with the indicated requirements.
C. Verify that mounting surfaces are ready to receive the system components.
D. Verify that branch circuit wiring is installed, completed, tested, and ready for connection to system.
E. Verify that conditions are satisfactory prior to starting work.
F. Device Locations

1. All device locations are to be field verified with the Owner prior to start of project. Architectural drawings are for approximation purposes only. Additional charges will not be allowed for outlet installation in areas not reviewed or approved by the Owner.

G. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.
H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install access control system in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Unless otherwise indicated, use wiring in conduit.

1. Use suitable listed cables in we locations, including underground raceways.
2. Use suitable listed cables for vertical wire applications.
3. All cabling shall be plenum rated.

D. Install wiring in conduit for the following:

a. Where required for rough-in.
b. Where required by the AHJ.
c. Where exposed to damage.
d. Where installed outside the building.
e. For exposed connections from outlet boxes to devices.

2. Conduit: comply with section 28 0528
3. Conceal cables unless specifically indicated to be exposed.

4. User power transfer hinges specified within Division 08 for concealed connections to door hardware.
5. Cables in the following areas may be exposed:

    a. Equipment Closets

6. Route exposed cables in parallel or perpendicular to building structural members and surfaces.
7. Do not exceed manufacturer's recommended maximum cable length between components.

E. Provide grounding and bonding in accordance with Division 26.
F. Install firestopping to preserve the fire resistance rating of partitions and other elements, using materials and methods specified in Division 07.
G. Install all devices and infrared illuminators level and plumb.
H. Install power supplies and other auxiliary components at control stations unless otherwise indicated.
I. Identify system components, wiring, cabling, and terminals according to ANSI/EIA/TIA standards.
J. Door Hardware Coordination

1. Doors shall not be locked in path of legal egress unless integrated with the fire alarm for release upon the fire alarm system notification. All access controlled locked door within the path of legal egress must be brought to the attention of the Architect and Security Consultant prior to rough-in.
2. Refer to Section Division 08 for Door Hardware requirements and coordination. Contractor shall work directly with door hardware supplier to ensure the provision of specified mechanical and electronic functionality.
3. Request to Exit Activation: Contractor shall configure the system such that Request to Exit devices and System Controllers will react quickly enough to bypass alarms before a fast-moving individual can reach and open the door. This bypass shall be evaluated and verified by the Contractor on the fully configured and operation Access Control system prior to acceptance testing. When possible, use door hardware with REX devices built into the hardware.
4. Fire Alarm Interface: Electrified locks, strikes and turnstiles which are part of this work and which may be locked in the path of legal exiting, shall be connected to the building Fire Alarm System in accordance with the AHJ requirement such that they automatically unlock in the event of activation of the Fire Alarm System. This shall occur whether the activation is a result of a manual pull station, smoke detector, or sprinkler flow switch.

    a. A fire alarm "general / common alarm relay" shall be programmed at the fire alarm control panel to activate the Access Control System interface relays located in each Lock Power Supply cabinet. The Access Control Contractor shall research and provide all necessary fire alarm system conduit, wire, hardware, and programming to perform required interface.
    b. This interface shall not depend on the Access Control System host or Remove Controllers for its operation. Locate these interface relays electrically ahead of lock power distribution. The Contractor shall supply and install programmed alarm interface relay(s) with sufficient capacity to control the power supplied to all controlled locks.

5. Access Control Lock Configuration

a. Secured Doors: Doors equipped with electric locks shall be individually programmed for locking and unlocking at specific times of the day. A valid credential presented at a reader will allow the portal to unlock for a programmed period of time.
b. Stairwell Door Locks:

    1) Stairwell doors which are locked from the stairwell side shall have the capability to be simultaneously unlocked upon a signal from the Fire Command Center, Fire Alarm Panel, or the Access Control Command Center when applicable.
    2) Stairwell locking systems shall, in all respects, comply with the requirements of the Building Codes for “Means of Egress”.
    3) Contractor shall provide clearly labeled switches, in the required locations, to unlock all stairwell doors simultaneously for “non-fire” emergencies. Coordinate wall or desk mounted switch style, with the Owner and the AHJ.
    4) This interface shall not depend on the Access Control System Host or Remote Controllers for its operation. Locate interface relays for each stairwell door electrically ahead of the Access Control System lock control, to independently override the Access Control System Control.

c. Upon authorization by card reader or manual means, “door force” and “door held open” alarms associated with the portals shall be automatically bypassed (prevented from reporting an alarm) for a duration of time that is programmable on an individual door and individual cardholder basis.
d. The door shall re-lock immediately upon closing, after an authorized access, and the bypass duration shall be immediately truncated. A door position switch will be required at every door for this purpose. The same door position switch shall be used to sense the position of the door for “door forced” and “door held open” alarms.
e. Free Egress Authorization

    1) Unless otherwise shown on the plans or described herein, the system shall detect the normal egress of a user at any individual portal and shall bypass any alarm associated with the portal for a duration of time that is programmable on an individual door and individual cardholder basis.
    2) Timing shall be independently programmed for each portal during the initial enrollment process. This function allows extended timing for disabled persons to pass through a portal.
    3) The timing function shall automatically truncate after an adjustable period (0-4 seconds) after a portal is closed. This feature allows a subsequent alarm at the portal to be detected and prevents the portal from being re-opened without an authorized request.
    4) “Request-to-Exit” devices shall be used to signal the system that an individual is ready to exit the secured door. Request-to-Exit devices may include but not be limited to:

        (a) Integral Lock Handle Signal Switches
        (b) Touch Bars (Electro-Mechanical or Electronic)
        (c) Push Bars (Mechanical)
        (d) Push Buttons

    5) On doors with integral electro-mechanical locking mechanisms (strikes, electrical panic hardware, or electrical mortise locks) the mechanical action of the door hardware shall enable egress without requiring release of the electrical mechanism. The Request-to-Exit device shall not unlock the door.

6) On doors with integral electro-mechanical locking mechanisms (magnetic locks), a Request-to-Exit device may unlock the door, releasing the electrical mechanism for the programmed duration. Refer to the drawings for details and direction.
7) On doors with Intercom Systems or Door Release Buttons, the Contractor shall interconnect the intercom system or door release button to activate the Request to Exit function and unlock the door. The door release request contact shall be connected to an input on the Access Control System, such that an event shall be registered into the Access Control System indicating its operation.

f. Sequences: Verify each door type sequence at each door with the Owner.

1) Doors with Door Position Switches (DPS) and Request-to-Exit (REX) Devices:

(a) DPS and REX contacts shall be wired to Access Control System auxiliary input. Configure the Access Control System to mask the associated DPS alarm for a minimum of 45 seconds. Coordinate the required masking duration with the Owner.
(b) Access Control System shall report a “door forced” alarm when any time the door is opened without a valid REX request. The subsequent operation of an associated REX shall not abort a “door forced” alarm already sensed by the system.
(c) Access Control System shall report a “door-held-open” alarm after the door has been opened and the masking duration has ended.

2) Doors with Electronic Locking (EL), DPS and REX devices:

(a) DPS and REX contacts shall be wired to Access Control System auxiliary input. Configure the Access Control System to mask the associated DPS alarm for a minimum of 45 seconds. Coordinate the required masking duration with the Owner.
(b) Electronic lock shall be wired to Access Control System auxiliary output. Configure the Access Control System to mask the associated DPS alarm during timed or commanded unlock.
(c) Electric lock shall be locked and unlocked based on preprogrammed schedules and conditions, and by manual control from the Access Control System client workstations.
(d) Access Control System shall not cause an alarm event when door is unlocked.
(e) Access Control System shall report a “door forced” alarm when any time the door is opened without a valid REX request. The subsequent operation of an associated REX shall not abort a “door forced” alarm already sensed by the system.
(f) Access Control System shall report a “door-held-open” alarm after the door has been opened and the masking duration has ended during locked mode.
(g) REX device shall not unlock the door.

3) Doors with Card Access Control (CR), EL, DPS and REX devices:

(a) CR, EL, DPS and REX devices shall be wired to a door controller board.
(b) Electronic lock shall be locked on command from the system at any time.
(c) Electronic lock shall unlock during a preset time zone or from the system.

(d) Electronic lock shall be unlocked and shall not require use of card reader during timed unlock mode.
(e) Access Control System shall not report activity when door is scheduled unlocked.
(f) During locked mode Card Reader shall unlock the door, mask DPS preventing alarm.
(g) Access Control System shall report a “door-held-open” alarm after the door has been opened and the masking duration has ended.
(h) Access Control System shall report a “door forced” alarm when any time the door is opened without a valid REX request. The subsequent operation of an associated REX shall not abort a “door forced” alarm already sensed by the system.
(i) REX device shall not unlock door.

4) Doors with Auto-Operators, Proximity CR, EL, DPS and REX devices:

(a) Auto-Operator controls, CR, EL, DPS and REX devices shall be wired to a door controller board.

5) Electronic lock shall be locked on command from the system at any time.

(a) Electronic lock shall unlock during a preset time zone.
(b) EACS shall not report alarm activity when door is unlocked.
(c) Auto-Operator door dwell times will meet all ADA/DDA requirements.
(d) Day mode: proximity card reader shall activate the auto operator to open the door.
(e) Secure mode: Card reader, auto operator function, shall activate the auto door operator at all times.
(f) Card Reader shall unlock the door, mask the DPS device preventing alarm and allow use of door open pushbuttons. Electronic lock to be unlocked prior to door open mechanism is engaged. Where auto door equipment is not provided with door open pushbuttons, the door shall automatically open after unlocking. NOTE: The exterior door open pushbutton should not function without first presenting a valid access card.
(g) Access Control System shall report a “door-held-open” alarm after the door has been opened and the masking duration has ended during locked mode.
(h) Access Control System shall report a “door forced” alarm when any time the door is opened without a valid REX request. The subsequent operation of an associated REX shall not abort a “door forced” alarm already sensed by the system.
(i) Use of push plate shall activate the Access Control System REX, unlock the door and operate the auto door system only after a valid card read.
(j) Door shall report a door held open time when REX (push plate or signal from the door operator) is activated, door is opened from the secured side and the system bypass time has expired during locked mode.
(k) Verify interior push plate is operational in both lock and unlocked modes.
(l) Verify exterior push plate is operational during unlocked mode.
(m) Verify exterior push plate is non-operational until valid card read during locked mode.
(n) Verify exterior push plate is operational after valid card read during locked mode.
(o) Verify door can be manually opened during locked mode from secured side.

g. Doors with Auto-Operators, Dual CR (Mag Stripe and Proximity types), EL, DPS and REX devices:

1) Auto-Operator controls, CR, EL, DPS and REX devices shall be wired to a door controller board.
2) Electric lock shall be locked on command from the system at any time.
3) Electric lock shall unlock during a preset time zone.
4) Door shall not report alarm activity when door is unlocked.
5) Secure mode:

(a) Proximity card reader, auto operator function, shall open the door at all times.
(b) During secure mode the card reader shall operate as item e above.

6) Access Control System shall report a “door-held-open” alarm after the door has been opened and the masking duration has ended during locked mode
7) Access Control System shall report a “door forced” alarm when any time the door is opened without a valid REX request. The subsequent operation of an associated REX shall not abort a “door forced” alarm already sensed by the system.
8) Use of push plate shall activate the Access Control System REX, unlock the door and operate the auto door system from the inside; however, the push plate will not operate the door from the exterior (secure) side unless there is a valid access card presented.
9) Door shall report a door held open time when REX (push plate or signal from the door operator) is activated, door is opened from the secured side and the system bypass time has expired during locked mode.
10) Verify interior push plate is operational in both locked and unlocked modes.
11) Verify exterior push plate is operational only during unlocked mode.
12) Verify exterior push plate is non-operational until valid card read during locked mode.
13) Verify exterior push plate is operational after valid card read during locked mode.
14) Verify door can be manually opened during locked mode from secured side.

h. Auto Sliding Doors shall operate similar to Doors with Auto-Operators (as applicable).

1) Contractor to coordinate and confirm door hardware includes electronic remote door locking control capability.
2) Verify sliding door break away feature is not disabled when door is in legal path of egress.

i. Exterior Gates:

1) Insert as defined by hardware group. [Provide gate with electric strike] [Provide gate with electrified mortise handle] CR, EL, DPS, REX wired to input / output / door controller card as required by application.
2) Gate shall operate as described for door with similar access control devices including being tied to the Fire Alarm System via a relay so the gates will unlock on receipt of a fire alarm.

6. Electrical Connections to Door Hardware: Wire connections to door hardware pigtail leads shall be made using the manufacturer-provided quick-connect devices, or by Dolphin insulated dis- placement connectors. Wire nuts and splices are not acceptable.
7. Tamper Devices

    a. Terminal cabinets, equipment cabinets, enclosures, power supply cabinets, exposed wireways, and pull and junction boxes with wire connections or splices shall be equipped with tamper switches programmed to report an alarm.
    b. Junction boxes requiring tamper switches that are associated with an individual alarmed de- vice (such as a door position switch) may report to the respective device alarm point if end- of-line resistors and the system are configured to support 6-state alarm reporting. Other cabinet and box tamper switches shall report as independent alarm points.
    c. Power Supply/Battery Chargers: Power supply/battery chargers shall be connected to alarm monitoring points to provide an "Event" indication of tamper, power failures and other system troubles.

K. Access Control System Connectivity

1. Access Control Network: Access Control Servers, Client Workstations and Controllers shall reside on the Owners' Local Area (LAN) and/or Wide Area Network (WAN) to allow global event activity and shared data interchange.
2. Provide and coordinate with Owner IT adequate network "firewalls" to maintain the security of Access Control System controls and information while connected to shared computer networks and transmission media. Contractor shall coordinate shared resource usage with the Owner, and develop network security schemes acceptable to the Owner to ensure the integrity of the Access Control System.
3. LAN Communications & Connectivity, (Integrated CPU's and Controller's)

    a. Provide LAN communications interfaces for the applicable Access Control System Server, Clients and Controllers to support multiple workstation and integration schemes that are part of this work.
    b. LAN Communications: Contractor shall utilize the facility's Local Area Network for Access Control System connections and interfaces, as shown on the drawings and described herein.
    c. Coordinate with Access Control System equipment and software manufacturers to provide network inter- face devices compatible with the established LAN/WAN network.
    d. Coordinate with the Owner's IT Department to provide servers, Access Control System clients, network interface devices, bandwidth utilization, and appurtenances acceptable to the Owner.

4. Controller Communications

    a. Between controllers at an individual location, and between controllers located within the same building, the controller network may be implemented using standard, twisted, shielded copper conductors as approved by the system manufacturer. It is also acceptable for controllers to be LAN connected, regardless of location.

L. Duress / Lockdown Alarm System

1. Furnish and install duress / lockdown alarm devices as shown on the Drawings, and as coordinated with final architectural millwork details, millwork shop drawings and consoles.
2. Wire alarm signal circuit using two-conductor twisted, shielded cable per cable specifications. Specified device contains latching L.E.D. Run additional two- conductor cable, dedicated to intrusion detection system, 12VDC power, per cable specifications, to power supply via reset switch at power supply.
3. Each hardwired duress alarm system device shall be wired to an Access Control input panel and intrusion detection remote field input module panels as separate 24 hour security zones.
4. Duress devices associated alarm signal circuitry to be fully supervised for open, short, normal and alarm. Provide required end-of-line resistors to achieve this supervision per manufacturer's specifications. Locate as close to device as possible, preferably in device homerun junction box. Protect wires from button to junction box using miniature Greenfield/stainless steel sheathing.
5. Provide separate 12 VDC, power kill, LED reset switch in security device low voltage power supply cabinet enclosure, and wire duress device LED power through switch. Label switch accordingly.

M. Emergency Standby Power

1. Low-Voltage Equipment: Access Control System Remote Controllers, peripheral devices and Lock Power Sup- plies shall have their own 4-hour battery back-up systems.

    a. Power back-up may be in the form of direct DC battery power back-up or by 120VAC Uninterruptable Power Supplies (UPS), depending upon equipment requirements.
    b. Lock Power Supplies shall allow fail-secure locks to be operated by the system a minimum of 100 times-per-hour, during this time period. Fail-safe locks shall be maintained for the full 4-hours.
    c. Battery back-up systems may be distributed throughout the facility to provide the required emergency power to individual components.
    d. Battery back-up systems shall include battery chargers to keep storage batteries at their peak charge.

N. Security System Integration

1. The Contractor shall be responsible for providing hardware and software interfaces to achieve the specified system performance described herein and, by reference, realize absolute and seamless compatibility with the related component systems.
2. The Contractor shall ensure system additions and modifications provided under this scope of work have no negative effect on the individual components and systems, and their core functionality, and no permanent effect beyond that specified or implied by the scope of work.
3. Purpose

    a. Integration is the process of designing, deploying, and configuring independently operating systems with the ability to request, receive, extract, process, and act upon information from other systems.
    b. Successful system integration must address three fundamental issues:

        1) Functionality: What information is needed, how it is to be requested and processed, and what functions or activities need to occur upon receipt of the information.

2) Connectivity: How systems will be connected to support the communication of information and commands. (Special interfaces, wiring, networks, databases.)
3) Communication: How information will be communicated between systems. (Instruction sets, language, protocols, formats, priority.)

4. Environment

a. Integration components shall generally comprise special elements of independent subsystems, and shall be located within, or in close proximity to, the processing components of each independent subsystem. Where subsystems require special hardware or communications interfaces to support integration, the special hardware should be located near the independent subsystem processing components or network appliance, based on the manufacturers' recommendation. See the drawings for details on mounting locations.
b. Central Administrative Post: Components of the main integration system operating shell may be distributed throughout the site / facility, in relation to the other integrated subsystems. The main EACS system monitoring occurs in the Massachusetts State House building Primary Security Operations Center (SOC – room 013A-1). System programming, rules configuration, and control shall occur either at this location or at another location designated by the Owner.

5. Infrastructure and Connectivity:

a. Devices/Appliances: Appliances and devices shall be connected to their respective systems via the applicable communications network.
b. System LAN/WAN Connectivity: System Servers and microprocessor-based Control Panels, shall reside on the Local Area Network (LAN) or Wide Area Network (WAN) tier designated for integrated components.
c. Enterprise: LAN networks will be connected to the Wide Area Network, to establish connectivity between remote sites and both the Primary and Alternate Security Operations Center (SOC – room SB05-1).

6. Attributes

a. The attributes of the integrated environment are primarily defined by the subsystems that are to be integrated. Verify existing system components to be expanded by this project.
b. Integrated systems comprise the processors, software, electrical control panels, data gathering panels, special data interfaces, and converters required to allow systems to communicate with each other, process information, and allow users to program and perform operations.

7. Functions

a. The system shall provide the following automated processing rules, at a minimum:
b. The object of "Access Control system integration" is to automatically configure the system to display, record, and report appropriate system activity to various elements of the system. Automatic configuration can free operators from difficult control tasks, give the operator more time to respond to events, reduce operator error, and ensure critical system tasks occur consistently.

c. Electronic Access Control system elements shall be electronically integrated in such a way as to enable detection, database records and/or event-initiated instructions to be communicated between system components, to initiate recording, display, communication, and control activities.
d. Event-Initiated Interface, General:

1) The system shall support the capability to send and receive alarm and control messages between the Access Control System and video systems via a LAN communications link, using API, XML, or other industry-standard communication languages and formats, and shall act upon those messages received.
2) The system shall support the capability to send and receive alarm and control messages and alarm signal between the Access Control system and Intrusion Detection System for lockdown / duress / and panic button initiation.
3) Where integration may require the implementation of data interfaces, Contractor shall propose such integration to the Owner for approval, before proceeding with the work.
4) Software routines required to accomplish the required data-interface with external equipment and controls will be fully developed, installed, tested and supported by the Contractor.
5) The manufacturer of each applicable system will also support the data interface and will be engaged by the Contractor to provide on-site technical assistance where required to prepare, repair, configure, and test the system to operational condition.
6) Communication of event information between systems shall take place automatically and immediately when the event is sensed by the System.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: The Contractor shall engage a qualified testing agency to perform tests and inspections with the Owner and appointed project manager.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements.
3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least fourteen (14) days. Provide a minimum of ten (10) days notice of test schedule.
4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

E. Access Control System shall be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.4 CLEANING

A. Remove rubbish and debris: Installation contractor is not allowed you use the onsite dumpster and is responsible to discard their own debris off site.
B. Clean installed items using methods and materials recommended in writing by manufacturer.
C. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 CLOSEOUT ACTIVITIES

A. See Division 01 – Closeout Submittals for Closeout Submittals.
B. Demonstration: Demonstrate proper operations of system to Owner and correct deficiencies or make adjustments as directed.
C. Training:

1. By means of training classes augmented by individual instruction as necessary, the Bidding contractor shall fully instruct the BOE's designated staff and personnel in the operation, adjustment and maintenance of all products, equipment and systems.
2. General Training Requirements:

a. The security contractor shall submit proposal to conduct training courses for the security personnel in the operation and maintenance of the security systems within this security project.
b. The security contractor shall include training manuals and aids in the quantity as requested by the Owner. The training manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. All personnel providing the instructions shall be certified by the equipment manufacturer for all applicable hardware and software.
c. Approval of the planned training content and training schedule shall be obtained by the Owner at least 45 days before the training is scheduled.
d. Training shall be provided by qualified, factory trained and certified engineers familiar with each system and its operations and shall be provided at the site for a period of no less than the hours stipulated below.

3. Training Topics:

a. System Administration Training

1) This training shall focus on determining and implementing system operational parameters.
2) The first training class shall be conducted so that it is completed approximately 30 days prior to acceptance of the system and final system reliability testing. 8 Hours of Administration training; (2) 4-hour classes.
3) The second training class shall be conducted so that it is completed approximately 7 days prior to acceptance of the system and final system testing. The system administrator shall be included as part of this final system acceptance and reliability testing. 6 Hours of training; (2) 3-hour classes.
4) This Administrations training shall include:

(a) Overall architecture and configuration of each system.
(b) Use of all system functions.
(c) ID badging design and production.
(d) Card-holder setup and configuration.
(e) Card-holder access level assignment.
(f) Access Door programming.
(g) Alarm setup and implementation.
(h) Data storage and retrieval through reports.
(i) Creation of reports.
(j) System database backup procedures.
(k) Hardware specifications.
(l) Fault diagnosis and corrections.

b. System User Monitoring Training

1) This training shall be for each designated personnel at this school.
2) This training shall focus on day-to-day system operations. Each user shall be capable to start the systems, operate them, recover the systems after a failure, and describe the specific hardware architecture and operation of the systems.
3) The first training class shall be conducted so that it is completed approximately 30 days prior to acceptance of the system and final system reliability testing. All System User Training shall be performed at each school within this specification. 8 Hours of User training; (2) 4-hour classes.
4) The second training class shall be conducted so that it is completed approximately 7 days prior to acceptance of the system and final system testing. The system administrator shall be included as part of this final system acceptance and reliability testing. 6 Hours of User training; (2) 3-hour classes.
5) Training shall include:

(a) Use of overall system monitoring functions as determined by the security administration staff.
(b) Monitoring alarm events.
(c) Monitoring personnel access into the facility.
(d) Assessing, responding to, and clearing alarms and messages.
(e) Monitoring access door status.
(f) Running routine reports.
(g) General hardware architecture.
(h) Functional operation of each system and interaction between these systems.
(i) All Operator commands.
(j) Database entry.
(k) Report generation.
(l) Alarm assessment.
(m) Simple diagnostics.

c. System Troubleshooting and Maintenance Training

1) Training shall be provided with the internal features and configuration of the security systems so the user can trouble shoot and repair most configuration and physical device problems.
2) The training class shall be conducted so that it is completed approximately 14 days prior to acceptance of the system and final reliability testing. The users

shall be included as part of this reliability testing. 8 Hours of training; (2) 4-hour classes.

3) This training shall include:

(a) System networking communications and diagnostics.
(b) Device configuration and programming.
(c) Controller setup.
(d) Wiring and cabling overview.
(e) System Diagnostics.
(f) Software troubleshooting.
(g) Physical layout of each piece of hardware.
(h) Preventive maintenance procedures and schedules.
(i) Calibration procedures.

d. IT Training

1) Training shall be provided information of the security systems to the IT staff. This shall include information as to how each system functions within the LAN/WAN network infrastructures. 4 Hours of training.
2) Topics shall include:

(a) Network topologies.
(b) Maintenance of data security.

4. Training hours and sessions must be documented by the instructor and approved by the Owner before project closeout.
5. Should the training be deemed as inadequate by the Owner, the owner reserves the right to retain outside manufacturer training. If this outside manufacturer training has an associated cost, this cost shall be deducted from the final invoice of this project.
6. The Owner reserves the right to request the Contractor to videotape training sessions and turn over video records (DVD format) to Owner as part of the “Owner Project Manuals” and Deliverables.

3.6 PROTECTION

A. Protect installed system components from subsequent construction operations.

3.7 MAINTENANCE

A. See Division 01 – Execution and Closeout Requirements for additional requirements relating to maintenance service.
B. Adjustments:

1. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two (2) visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:

a. Check cable connections.
b. Check proper operation of access control devices.

c. Provide a written report of adjustments and recommendations.

C. Provide to Owner, at no extra cost, a separate maintenance contract for the service and maintenance of the Access Control System for One Year from date of Substantial Completion. Include a separate description of preventative maintenance, systematic examination, cleaning, inspection, and testing, with a detailed schedule.
D. Conduct site visit at least once every three months to perform inspection, testing, and preventative maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.
E. 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 the site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION 28 1300

SECTION 28 1600
INTRUSION DETECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to the following construction documents for Data Room locations and device locations only.

1. "T" Drawings – Technology Plans

1.2 SUMMARY

A. The scope of work required as part of this project shall include a new intrusion detection system installed into the school.
B. Section Includes:

1. Control Panel
2. Motion Sensors
3. Door Contacts
4. Intrusion detection devices

C. These specifications contain the functional and operational requirements for an integrated intrusion alarm system employing motion detection devices and door contacts as the primary means of intrusion detection for selected interior protection. This procurement shall include all the equipment required at various facilities as shown on the Drawings.
D. Responsibility for the integrated security systems and equipment is specified in the following sections and shall be coordinated with the finish door hardware and Fire Alarm sections.
E. The intrusion system is intended to provide protection of selected facilities against intrusion and for the detecting or discouraging of burglary or vandalism during the hours the facilities are unoccupied and report signal to the Central Station.
F. General: Provide and install an integrated security system and all devices, terminations, associated supporting devices, configuration of system, testing and training in accordance with this Bid package to provide a complete and functional system.
G. The cabling shall be provided and installed by the contractor awarded this project and as described within the construction bid document and referenced on the drawings associated with this bid package. All other cabling required to provide a complete and functional system shall be furnished and installed by the Contractor awarded this portion of work.
H. This specification is used to identify the requirements for integrated Burglar entry systems encompassing door contacts and motion detectors.
I. Responsibility for the integrated security systems and equipment is specified in the following sections and shall be coordinated with the Finish Hardware and Fire Alarm sections of the Phase I Construction.
J. It is the intent of these specifications to procure a fully acceptable, effective and reliable integrated security system. Refer to the Drawings for division of responsibility. These specifications recognize the importance of complete system operation and are not limited to specifying of equipment only. The following are also required from the selected bidder:

1. Proven experience in the security business.
2. Prompt delivery and professional installation including service of equipment as specified.
3. Bidder must provide, for objective evaluation, references, which clearly state and show the effectiveness of proposed equipment and services.
4. Used products will not be acceptable. Manufacturer must satisfactorily demonstrate that he has supplied and will continue to supply products to avoid the obsolescence of equipment installed in the building.
5. All equipment shall be fully guaranteed for twelve (12) months. This guarantee shall become effective from the day of installation completion. When in normal operation, if the equipment is found to be below the manufacturer's specification, repair and replacement of equipment shall be provided. Repairs shall be started within twenty-four (24) hours and completed without delay. Installation contractor shall either stock spares or be capable of obtaining all required replacement parts within twenty-four (24) hours.
6. Extended warranty terms shall be provided by the installing security system integrator at the time of bid.

1.3 SYSTEM DESCRIPTION

A. The system shall be a Burglary/Access Control/CCTV Switching System that includes the following capabilities:

1. Listed for UL Commercial Burglary VISTA-250BPT - 1 Detection and Alarm
2. Supports up to 128 (250) zones.
3. Supports up to eight (8) separate partitions.
4. Supports up to one hundred fifty (150) users.
5. Provides integrated security, access control, and CCTV switching capability.
6. Provides supervision of peripheral devices.
7. Supports up to ninety-six (96) optional relay outputs.
8. Supports long-range radio (LRR) communication.
9. Provides scheduling capability to allow for automated operations.
10. Supports up to eight (8) alphanumeric paging devices.
11. Supports panel linking.
12. Supports alarm reporting via Internet.
13. Interfaces with automation software.
14. Capable of being installed using existing wiring.

1.4 APPLICABLE STANDARDS

A. All of the work within the scope of this bid shall be performed in accordance with the applicable state, county and city laws and ordinances. The bidder shall be able to obtain all permits and licenses as required in addition to being a licensed contractor. All materials, supplies and equipment being furnished shall be installed in accordance with the latest version of the applicable standards of:

1. OSHA
2. Uniform Building Code
3. Americans with Disabilities Act (ADA)
4. Components of the system shall be of the type approved by Safety and Regulatory Agencies including:

    a. Underwriters' Laboratories (UL), Inc.
    b. Federal Communications Commission (FCC).

c. Agency approvals and UL Listing declare the system's design, components, and installation shall meet the highest standards.
d. System installation shall comply with UL 681 and UL 611.

5. Alarm detection systems intended for UL certified fire alarm reporting shall meet the requirements of UL Standard 985, NFPA Standard 72 Chapter 2.
6. The equipment shall comply with Part 68 of the FCC Telephone Requirements Rules.
7. All circuits and equipment shall be installed and protected according to the National Electric Code and any applicable local requirements.

1.5 DEFINITIONS

A. LCD: Liquid-crystal display.
B. LED: Light-emitting diode.
C. PIR: Passive infrared.
D. RFI: Radio-frequency interference.
E. Protected or Protection Zone: A space or area for which an intrusion must be detected and uniquely identified, the sensor or group of sensors assigned to perform the detection, and any interface equipment between sensors and communication link to central-station control unit.

1.6 SUBMITTALS

A. Product Data: Components for sensing, detecting, systems integration, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
B. High Performance Building Submittal Requirements: The contractor or subcontractor must submit the following High Performance Building certification items:

1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:

a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.

2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
3. Product Cut Sheets for all materials that meet the High Building Performance Requirements this Section.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

C. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

1. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify programmable logic controllers, networks, and control interface devices and media to be used. Describe characteristics of network and other data communication lines.
2. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection and for systems integration. Include designation of devices connected by raceway, raceway type, and size, and type and size of wire and cable fill for each raceway run.
3. Device Address List: Coordinate with final system programming.
4. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
5. Sensor detection patterns and adjustment ranges.

D. Equipment and System Operation Description: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are not acceptable.
E. Field quality-control test reports.
F. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Data for each type of product, including features and operating sequences, both automatic and manual.
2. Central-station control-unit hardware and software data.

G. Warranty: Special warranty specified in this Section.
H. In the event that the installation contractor does not furnish or does not supply sufficient documentation, the owner has the right to engage a separate contractor to attain any or all required documentation. All costs related with this event shall result in a back charge to the installation vendor via a change order.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. An employer of workers, at least one of whom is a technician certified by the National Burglar & Fire Alarm Association.
2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
3. A copy of the Contractors Certified Installers Certificate shall be furnished with bid response.

B. Intrusion Detection Systems Integrator Qualifications: An experienced intrusion detection equipment supplier and/or Installer who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. FMG Compliance: FMG-approved and -labeled intrusion detection devices and equipment.
E. Comply with NFPA 70.
F. Electrical Power

1. Normal System Power Supply: 120V, 60Hz, through a locked disconnect device and an isolation transformer in a central-station control unit. Central-station control unit shall supply power to all components connected to it unless otherwise indicated.
2. Power Continuity for Central-Station Control Units: Batteries in power supplies of the central-station control unit and individual system components shall maintain continuous system operation during outages of both the normal and backup ac system supply.

a. Batteries: Rechargeable, valve-regulated, recombinant, sealed, lead-acid type with nominal ten (10) year life expectancy. Capacity adequate to operate portion of system served, including audible trouble signal devices for up to four (4) hours and audible and visual alarm devices under alarm condition for an additional ten (10) minutes.
b. Battery Charger: Solid-state fully automatic, variable-charging-rate type. Charger shall recharge fully discharged battery within twenty-four (24) hours.

G. Annunciation: Indicate a change in system condition and switching of system or component to backup power.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fails in materials or workmanship within specified warranty period.

1. Warranty Period: The standard manufacturer’s warranty shall apply or a minimum of a one (1) year warranty from the date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturer:

1. The systems specified is based on the following manufacturer:

a. Manufacturer: Honeywell Vista 128BPT or Honeywell Vista 250BPT or as other wise specified within the drawing package.
b. Approved alternate manufacturers:

1) Bosch G Series Intrusion Detection Panels
2) DMP XR550DN Intrusion Detection Panels

2. The main panel shall be sized to accommodate all the devices within the plans for each school and include an additional headroom of forty percent (40%) expansion.
3. System Performance:

a. Control Panel – The control panel shall be an eight (8)-partition, UL commercial burglary control panel that supports up to one hundred twenty-eight (128) zones using basic hardwired, polling loop, and wireless zones. It shall also provide supervision of the bell output, RF receivers, and relay modules. In addition, the control shall provide the ability to schedule time-driven events, and allow certain operations to be automated by pressing a single button. The system shall be capable of interfacing with an ECP long range radio (LRR) unit that can send Contact ID messages, and alphanumeric paging devices. The control shall provide integrated access control and CCTV-switching capability.

1) Basic Hardwired Zones – The control shall provide nine (9) style-B hardwire zones with the following characteristics:

(a) EOLR Supervision (optional for Zones 2-8): Shall support N.O. or N.C. sensors (EOLR supervision required for UL installations).
(b) Individually assignable to one (1) of eight (8) partitions.
(c) Supports up to sixteen (16) two-wire smoke detectors on one (1) selected zone.
(d) Supports four-wire smoke or heat detectors on any zone (power to four-wire smoke detectors must be supervised with an EOL device).
(e) Supports up to fifty (50) two-wire latching glass break detectors on one (1) selected zone.

b. Expansion Zones

1) Polling Loop Expansion – The control shall support up to one hundred nineteen (119) additional hardwire zones using a built-in two-wire polling (multiplex) loop interface. The polling loop shall provide power and data to remote point modules, and constantly monitor the status of all zones on the loop. Maximum current draw shall not exceed 128 mA. The polling loop zones shall have the following characteristics:

(a) Interface with RPM (Remote Point Module) devices that provide Class B, Style Y (e.g., 4208U/4208SN) or a combination of Class B, Style Y, and Class A, Style Z (e.g., 4208SNF) zones.
(b) Individually assignable to one (1) of eight (8) partitions.
(c) Supervised by the control panel.
(d) A 12,000 foot wire run capability without using shielded cable.
(e) Each RPM (Remote Point Module) enclosure shall be tamper protected.

c. Partitions – The control shall provide the ability to operate eight (8) separate areas, each functioning as if it had its own control. Partitioning features shall include:

1) A Common Lobby partition (1-8), which can be programmed to perform the following functions:

(a) Arms automatically when the last partition that shares the common lobby is armed.
(b) Disarms when the first partition that shares the common lobby is disarmed.

2) A Master partition (9), used strictly to assign keypads for the purpose of viewing the status of all eight (8) partitions at the same time (master keypads).
3) Assignable by zone.
4) Assignable by keypad.
5) Assignable by relay to one or all eight (8) partitions.
6) Ability to display fire and/or burglary and panic and/or trouble conditions at all other partitions' keypads (selectable option).
7) Certain system options selectable by partition, such as entry/exit delay and subscriber account number.

d. User Codes – The control shall accommodate one hundred fifty (150) user codes, all of which can operate any or all partitions. Certain characteristics must be assignable to each user code, as follows:

1) Authority level (Master, Manager, or several other Operator levels). Each User Code (other than the installer code) shall be capable of being assigned the same or a different level of authority for each partition that it will operate.
2) Opening/Closing central station reporting option.
3) Specific partitions that the code can operate.

e. Global arming capability (ability to arm all partitions the code has access to in one (1) command).

1) Use of an RF (button) to arm and disarm the system (RF key must first be enrolled into the system).

f. Peripheral Devices – The control shall support up to thirty (30) addressable ECP devices, which can be any combination of keypads, RF receivers, relay modules, annunciator modules, and interactive phone modules. Peripheral devices have the following characteristics:

1) Each device set to an individual address according to the device's instructions.
2) Each device enabled in system programming.
3) Each device's address shall be supervisable (via a programming option).

g. Keypad/Annunciator – The control shall accommodate up to sixteen (16) keypads or six (6) touch-screen (i.e., advanced user interface) keypads. The keypads shall be capable of the following:

1) Performing all system arming functions.
2) Being assigned to any partition.
3) Providing four programmable single-button function keys, which can be used for:

(a) Panic Functions –activated by wired and wireless keypads; reported separately by partition.

h. Keypad Macros – Thirty-two (32) keypad macro commands per system (each macro is a series of keypad commands). Assignable to the A, B, C, and D keys by partition.

i. Vista Interactive Phone Module – The control shall support the ADEMCO 4285/4286 VIP Modules, which permit access to the security system in order to perform the following functions:

1) Obtain system status information. Arm and disarm the security system. Control relays.
2) Arm and disarm the security system.
3) Control relays.

j. LED Annunciator – The control shall support the ADEMCO FSA-8 and FSA-24 annunciators, which are capable of:

1) Visually identifying a zone or point that is in alarm or trouble.
2) Programmable for system silence/reset.
3) Up to ninety-six (96) LEDs may be used in one system.
4) A total of four (4) FSA-24 or 12 FSA-8 annunciators may be used in one (1) system.
5) An optional keyswitch, FSAKSM module, shall be available for UL listed Silence and Reset capability.

k. Voltage Triggers – The system shall provide voltage triggers, which change state for different conditions. Used with LRR (Long Range Radio) equipment or other devices such as a remote keypad sounder, keyswitch ARMED and READY LEDs, or a printer to print the system's event log.

l. Event Log – The System shall maintain a log of different event types (enabled in programming). The event log shall provide the following characteristics:

1) Stores up to five hundred twelve (512) events.
2) Viewable at the keypad or through the use of Compass software.
3) Printable on a serial printer using a 4100SM Module including zone alpha descriptors.
4) Stores PassPoint access control events.
5) Sends printed events to up to eight (8) alpha numeric pagers.

m. Scheduling – Provides the following scheduling capabilities:

1) Open/close schedules (for control of arming/disarming and reporting).
2) Holiday schedules (allows different time windows for open/close schedules).
3) Timed events (for activation of relays, auto-bypassing and un- bypassing, auto-arming and disarming, etc.).
4) Access schedules (for limiting system access to users by time).
5) End User Output Programming Mode (provides twenty (20) timers for relay control).
6) The system shall automatically adjust for daylight savings time.

n. Communication Features – Supports the following formats and features for the primary and secondary central station receivers:

1) Formats.

(a) ADEMCO Low Speed (Standard or Expanded).
(b) Sescoa/Radionics.
(c) ADEMCO Express.
(d) ADEMCO High Speed.
(e) ADEMCO Contact ID.

2) Backup Reporting – The system shall support backup reporting via the following:

(a) Secondary phone number.
(b) ECP long range radio (LRR) interface.
(c) Option to select long range radio (LRR) or dialup as the primary reporting method (dynamic signaling feature).

3) Internet Reporting – The system shall be capable of communicating with the central station via the internet using Alarmnet-i. It shall provide the user with the ability to control the system via a browser interface (i.e., AOL, Netscape, Internet Explorer). All packet data transmitted to the monitoring station shall be encrypted with a minimum of 1024 bits of encryption.

o. Audio Alarm Verification Option – Provides a programmable Audio Alarm Verification (AAV) option that can be used in conjunction with an output relay to permit voice dialog between an operator at the central station and a person at the premises.

4. Cross-Zoning Capability - Helps prevent false alarms by preventing a zone from going into alarm unless its cross-zone is also faulted within 5 minutes.

a. Pager Interface – The Control Panel shall be capable of sending event information to an alphanumeric pager via a VA-8201 pager interface device.
b. Exit Error False Alarm Prevention Feature – The System shall be capable of differentiating between an actual alarm and an alarm caused by leaving an entry/exit door open. If not subsequently disarmed, the control panel shall:

1) Bypass the faulted E/E zone(s) and/or interior zones and arm the system.
2) Generate an Exit Error report by user and by zone so the central station knows it was an exit alarm and who caused it.

c. Built-in User's Manual and Descriptor Review – For end-user convenience, the control panel shall contain a built-in User's Manual. It shall include the following capabilities:

1) By depressing any of the function keys on the keypad for 5 seconds, a brief explanation of that function shall scroll across the alphanumeric display.
2) By depressing the READY key for 5 seconds, all programmed zone descriptors shall be displayed (one (1) at a time). This feature shall provide a check for installers and ensure all descriptors have been entered properly.

d. Programming – The Control shall be capable of being programmed locally or remotely using the ADEMCO Compass Downloader and shall be capable of:

1) Uploading and downloading all programming information at 300 baud.

2) Uploading and displaying firmware revision levels from the control.

e. Panel Linking – The Control shall be capable of being networked together with up to eight other controls and being operated by any keypad within the system. It shall provide the ability for users to:

1) Control multiple zones, partitions, and/or buildings from a central location.
2) Check status, arm and disarm any partition from any keypad in the system.
3) Globally arm or disarm partitions based upon user authority.

f. Automation Software – The Control shall be capable of interfacing with automation software via an RS232 input on a single partition.

2.2 COMMUNICATION DEVICE

A. HONEYWELL #GSMV4G or equivalent Digital Cellular Communicator for VISTA Control Panels
B. Features

1. Multi-GSM platform compatibility —2G, 3G and 4G.
2. Automatic selection of the best available GSM network.
3. 4G capable using HSPA+ protocol.
4. Full Contact ID or ADEMCO® High-Speed Reporting – Contact ID reporting using ECP mode with compatible Honeywell control panels or combined with optional dialer capture for non-ECP capable control panels.
5. 256-bit AES Encryption – Advanced encryption standard used for secure communications.
6. Upload/Download – Available with select Honeywell control panels. Requires Compass version 1.5.8.54a or higher.
7. Integration – Quick and easy installation of GSM for VISTA® and LYNX controls.
8. Dynamic Signaling with Certain Honeywell Control Panels – Provides management of control panel dialer and digital cellular communicator. Programmable priority and delays determine signal path.
9. Diagnostic LEDs – Provide signal strength and status indications.
10. QOS – Quality of Service diagnostics via AlarmNet supply vital information including when a message was received, battery voltage, input voltage, signal strength and message path.
11. Web-Based Programming – Allows complete interactive programming from AlarmNet Direct. Error! Hyperlink reference not valid.
12. Intelligent Supervision – Any message generated serves as a supervision message per optional twenty-four (24) hour or thirty (30) day intervals. This feature effectively limits required messages to be sent.
13. Remote Services Capability* - Optional Honeywell Total Connect™ Remote Services value-added web-based or SMS system control as well as e-mail notification of system events.
14. Two-way Voice Transport – GSM voice channel capable to allow two-way voice session in conjunction with an audio verification system (GSMX4G/iGSMV4G/GSMV4G/ VISTA-GSM4G).

2.3 DOOR CONTACTS

A. Surface Mounted Contact, Addressable:

1. HONEYWELL #4939SN or compatible with Honeywell VPLEX.

B. Overhead Door Contacts, Addressable:

1. HONEYWELL #4959SN or compatible with Honeywell VPLEX.

2.4 MICROWAVE – PIR, VPLEX TECHNOLOGY MOTION SENSORS

A. Wall mounted PIR Motion Sensor or equivalent:

1. HONEYWELL #IS-3050A-SN or compatible with Honeywell VPLEX.

a. Description: Sensors detect intrusion by monitoring infrared wavelengths emitted from a human body within the protected zone(s) and by being insensitive to the general thermal variations.
b. Wall-Mounting Unit Maximum Detection Range: One hundred twenty-five percent (125%) of indicated distance for an individual unit and shall not be less than 50 feet.

B. Ceiling Mounted, 360 degree PIR Motion Sensor or equivalent

1. HONEYWELL #DT-8360CM-SN or compatible with Honeywell VPLEX.

2.5 GLASS BREAK DETECTOR – VPLEX TECHNOLOGY

A. Ceiling or Wall Mounted, 360 degree PIR Motion Sensor or equivalent

1. HONEYWELL #FG-16W5SN or compatible with Honeywell VPLEX.

2.6 PANIC BUTTON

A. Sentrol #3050 or compatible with Honeywell VPLEX.

2.7 ADDRESSABLE ZONE INPUT DEVICE

A. HONEYWELL #4193SNP

1. Can be located anywhere along the two-wire addressable V-Plex® bus.
2. Converts any conventional detection device to an addressable device. Conventional detector must provide dry-contact output.
3. System automatically learns device serial number so no DIP switch addressing is required.
4. Small size fits easily into most sensing detector enclosures or splice boxes.
5. Two-Zone Inputs: One (1) supervised with 10K EOL resistor, one unsupervised loop.
6. Loop 1 provides a broad, 300 ohm tolerance.
7. Supervised for open, shorted or normal circuit conditions.

B. UL Listed for commercial burglary and fire alarm applications.

2.8 POLLING LOOP EXTENDER MODULE

A. HONEYWELL #4297

1. Extender modules shall be installed to isolate and protect separate areas of the facility.
2. Extender modules shall be distributed throughout the facility as required to assist in distance limitations.

2.9 ALARM KEYPAD CONSOLE

A. HONEYWELL #6160 Console

2.10 ENCLOSURE

A. The Control Panel shall be enclosed in a metal cabinet, suitable for wall mounting. The dimensions shall not exceed 14.5 inches in height, 12.5 inches in width or 3 inches in depth.

2.11 ELECTRICAL POWER REQUIREMENTS

A. System Power – The Fire and Burglary Alarm System shall operate using standard 120 volts AC, 50/60 Hz power.

1. Control Primary Power – Transformer power shall be 16.5 VAC, 40VA.
2. Backup Battery – A rechargeable 12 VDC, gel type, lead acid backup battery shall be provided. The battery shall be rated between 7 and 34- ampere hours (AH).
3. Alarm Power – Alarm power shall be 12 VDC, 1.7 amps for each bell output
4. Auxiliary Standby Power – Standby power shall be 12 VDC, 750 mA maximum.
5. Fusing – The battery input, auxiliary, and bell outputs shall be protected using PTC circuit breakers. All outputs shall be power limited.

2.12 SUBSTITUTIONS

A. Substitution of any item shall only be permitted when the Owner waives the specification(s) of a particular product(s) in writing, allowing a substitute item to be bid. It shall be the responsibility of the Contractor requesting the substitution that the proposed item is equivalent in each and every way to the originally specified product stated within this bid specification and drawing package and that it is in the best interest of the Owner to use the proposed substitute.

PART 3 EXECUTION

3.1 COMMISSIONING OF SYSTEMS AND EQUIPMENT

A. Engage a factory-authorized service representative or technician who is familiar with this project to participate and assist, if necessary, in the functional performance testing of the equipment include in this Division with the Commissioning Agent.

3.2 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of intrusion detection.

1. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.
2. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.

B. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Re-inspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.

C. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 SYSTEM INSTALLATION

A. The System shall be installed and tested in accordance with the Manufacturer's Installation instructions. The following conditions are applicable:
B. In order to ensure a complete, functional System, for bidding purposes, where information is not available from the Owner upon request, the worst case condition shall be assumed.
C. Interfaces shall be coordinated with the Owner's representative, where appropriate.
D. All necessary backboxes, pullboxes, connectors, supports, conduit, cable, and wire shall be furnished and installed to provide a complete and reliable System installation.
E. All conduit, cable, and wire shall be installed parallel and square with building lines. Conduit fill shall not exceed forty percent (40%). All wires shall be gathered, labeled and tied to create an orderly installation.
F. Comply with UL 681.

3.4 WIRING INSTALLATION

A. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
B. Wires and Cables:

1. Conductors: Size as recommended in writing by system manufacturer, unless otherwise indicated.

C. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
D. Install power supplies and other auxiliary components for detection devices at controllers, unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.
E. Identify components with engraved, laminated-plastic or metal nameplate for central-station control unit and each terminal cabinet, mounted with corrosion-resistant screws.

3.5 GROUNDING

A. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
B. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.
C. Install grounding electrodes of type, size, location, and quantity indicated.

3.6 FIELD QUALITY CONTROL

A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.

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

1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
2. Operational Tests: Schedule tests after pretesting has been successfully completed. Test all modes of system operation and intrusion detection at each detection device. Test for detection of intrusion and for false alarms in each protected zone. Test for false alarms by simulating activities outside indicated detection patterns.
3. Electrical Tests: Comply with NFPA 72, Section A-7. Minimum required tests are as follows:

a. Verify the absence of unwanted voltages between circuit conductors and ground.
b. Test all conductors for short circuits using an insulation-testing device.
c. With each circuit pair, short circuit at the far end of circuit and measure circuit resistance with an ohmmeter. Record circuit resistance of each circuit on Record Drawings.
d. Verify that each controller is in normal condition as detailed in manufacturer's operation and maintenance manual.
e. Verify that transient surge-protection devices are installed according to manufacturer's written instructions.
f. Test each initiating and indicating device for alarm operation and proper response at central-station control unit.

C. Report of Tests and Inspections: Prepare a written record of tests, inspections, and detailed test results in the form of a test log.
D. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within twelve (12) months of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three (3) visits to Project during other than normal occupancy hours for this purpose. Visits for this purpose shall be in addition to any required by warranty.

3.8 CLEANING

A. Remove rubbish and debris: Installation contractor is not allowed you use the onsite dumpster and is responsible to discard their own debris off site.
B. Clean installed items using methods and materials recommended in writing by manufacturer.

3.9 DEMONSTRATION – TRAINING

A. By means of training classes augmented by individual instruction as necessary, the Bidding contractor shall fully instruct the BOE's designated staff and personnel in the operation, adjustment and maintenance of all products, equipment and systems.
B. The Contractor shall be required to provide all training aids, e.g., notebooks, manuals as required.
C. All training shall be completed a minimum of two (2) weeks prior to system cut over. Training schedule shall be subject to the Owner approval.
D. Training shall be conducted by experienced personnel and supported by training aids. An adequate number and amount of training material shall be provided by the Contractor. The following is considered a minimum.

    1. Functional flow-charts, overall block diagrams, and descriptive material for all software;
    2. Schematic drawings for each of the hardware components;
    3. All procedure manuals, specification manuals, and operating manuals;
    4. As-built drawings.

E. Bidding contractor shall engage a factory-authorized service representative to provide formal training the Owner's maintenance personnel to adjust, operate, and maintain this Intrusion Detection system.
F. Training shall include the following:

    1. User Training; Eight (8) hours of instruction to the users at EACH school within this project shall be included as part of this specification. Eight (8) hours of instruction per school is required.
    2. Administrator Training; Twenty four (24) hours of advanced system administration training to the administrator of this system shall be included as part of this specification.
    3. All training shall be divided up into four (4) hour sessions as mandated by the Owner.

G. Training hours and sessions must be documented by the instructor and approved by the Owner before project closeout.

H. Should the training be deemed as inadequate by the owner, the owner reserves the right to retain outside manufacturer training. If this outside manufacturer training has an associated cost, this cost shall be deducted from the final invoice of this project.

END OF SECTION 28 1600

SECTION 28 23 00
VIDEO SURVEILLANCE SYSTEM

SECTION 1 - GENERAL

1.1 SECTION INCLUDES

A. System Requirements
B. Uninterruptible Power Supplies
C. Surge Protection
D. Client Workstations
E. Cameras
F. Video Surveillance Software

1.2 RELATED REQUIREMENTS

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.” OR Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Division 07 - Firestopping.
C. Division 08 - Door Hardware: Electrically operated door hardware, for interface with access control system. Includes door hardware with integral request to exit devices.
D. Division 11 - Parking Control Equipment: Parking gates, for interface with access control system.
E. Division 14 - Electric Traction Elevators: For interface with access control system.
F. Division 14 - Hydraulic Elevators: For interface with access control system.
G. Division 26 - Grounding and Bonding for Electrical Systems.
H. Division 26 - Conduit for Electrical Systems.
I. Division 26 - Identification for Electrical Systems: Identification products and requirements.
J. Division 27 - Structured Cabling: Data cables for access control system IP network connections.
K. Division 28 - Access Control: For interface with access control system.
L. Division 28 - Building Intrusion Detection: For interface with access control system.
M. Division 26 - Fire Detection and Alarm: For interface with access control system.
N. Refer to the following construction documents for Data Room locations and device locations only.

    1. “T” Drawings – Technology Plans

O. Any apparatus, appliance, material, or work not shown on the Drawings but mentioned in the Specifications, or vice versa, and any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation, even if not particularly specified, shall be provided without additional expense. Coordinate with each system manufacturer to insure all hardware, firmware, relays, or other necessary components are provided prior to bid submission.
P. All work of this Section to comply with the requirements of the Conditions of Contract, with all Specification Sections of Division 01 – General Requirements, with the Security Drawings, and with all other Contract Documents.
Q. Refer to Division 26 of the Contract Documents, Electrical, for all Specifications governing the installation of raceway (conduit, EMT, cable trays, wire trough, etc.), system junction and pull

boxes, and device rough-in boxes, for all Security System work shown on the Security Drawings. Conduit, back box, and trough work to be provided by this Contractor.

R. Refer to Division 26 of the Contract Documents, Electrical, for all work related to the interconnection of Security System equipment to 120 VAC power sources.
S. Refer to Division 09 of the Contract Documents, Finishes, for details relating to acoustical ceilings and gypsum board systems, floor finishes, painting, etc., for information pertinent to device and back box selection and installation.
T. Refer to Division 08 of the Contract Documents, Openings, for details relating to doors, door frames, windows, and window frames, for information pertinent to the selection of magnetic contact devices and their associated placement and installation, including back box selection and installation.
U. Refer to Division 08 of the Contract Documents, Openings, for details relating to door and door frame hardware and preparation, electrified lock power supplies, required coordination to accommodate these components and/or systems, lock voltage and current draw coordination, coordination of fail-safe electrified locks, and any other related equipment or requirements
V. Refer to Division 27, Telecommunications for all Ethernet Cabling for the Cameras.
W. Review all other Specification Sections as required to achieve complete inter- trade coordination.

1.3 DEFINITIONS

A. API: Application Programming Interface
B. AVI: Audio Video Interleave
C. CA: Certificate Authority
D. CAC: Common Access Card
E. CE: European Union Conformity
F. CPU: Central Processing Unit
G. CSV: Comma Separated Values
H. DNS: Domain Name Server
I. DSM: Door Status Monitor
J. DVR: Digital Video Recorder
K. EACS: Electronic Access Control System
L. FCC: Federal Communications Commission
M. FIPS: Federal Information Processing Standard
N. FIFO: First In – First Out
O. FTP: File Transfer Protocol
P. FRAC: First Responder Authentication Credential
Q. GB: Gigabyte
R. GSOC: Global Security Operations Center
S. GUI: Graphical User Interface
T. HA: High Availability
U. HTML: Hypertext Markup Language
V. H.264, H.265: Video Compression Standards
W. I^2C: Inter-Integrated Circuit
X. IEEE: Institute of Electrical and Electronics Engineers
Y. I/O: Input / Output
Z. IP: Internet Protocol
AA. IS: Integrated System
BB. JPEG: Joint Photographic Experts Group
CC. LAN: Local Area Network
DD. LDAP: Lightweight Directory Access Protocol
EE. MB: Megabyte
FF. MJPEG: Motion JPEG
GG. MSATA: Mini-Serial Advanced Technology Attachment
HH. MSP: Mobile Security Professional

II. MTBF: Mean-Time Between Failure
JJ. NAS: Network Attached Storage
KK. NAT: Network Address Translation
LL. NBAPI: NetBox Application Programming Interface
MM. NECA: National Electric Code Association
NN. NFPA: National Fire Protection Association
OO. NVR: Network Video Recorder
PP. ODBC: Open Database Connectivity
QQ. OS: Operating System
RR. OVID: Open Video Integration Driver
SS. PDF: Portable Document Format
TT. PIN: Personal Identification Number
UU. PIV: Personal Identity Verification
VV. PoE: Power over Ethernet
WW. PTZ: Pan-Tilt-Zoom
XX. RAID: Redundant Array of Independent Disks
YY. RAM: Random Access Memory
ZZ. REX: Request to Exit
AAA. RFID: Radio Frequency Identification
BBB. RoHS: Restriction of Hazardous Substances
CCC. ROM: Read Only Memory
DDD. RU: Rack Unit
EEE. SFTP: Secure File Transfer Protocol
FFF. SHA: Secure Hash Algorithm
GGG. SIO: Serial Input / Output
HHH. SLA: Sealed Lead-Acid
III. SMS: Security Management System or Short Message Service (text messaging)
JJJ. SSL: Secure Sockets Layer
KKK. SUSP: Software Upgrade and Support Plan
LLL. TCP: Transmission control protocol - connects hosts on the Internet
MMM. TIA: Telecommunications Industry Association
NNN. TLS: Transport Layer Security
OOO. TWIC: Transportation Worker Identification Credential
PPP. UI: User Interface
QQQ. UPS: Uninterruptible Power Supply
RRR. UTP: Unshielded Twisted Pair
SSS. VMS: Video Management System
TTT. WAN: Wide Area Network
UUU. Wi-Fi: Wireless Network
VVV. AS NECESSARY: Shall mean work which is required for completed construction, but is not necessarily shown or described in the Contract Documents.
WWW. AS REQUIRED: Shall mean work which is required for completed construction, but is not necessarily shown or described in the Contract Documents.
XXX. Substantial Completion: Shall mean that the project is sufficiently complete to be utilized for its intended use as stated in the body of this written specification.
YYY. Contractor/INTEGRATOR: Refers to the biding/installation Contractor responsible for furnishing and installation of all work indicated within this specification.

1.4 REFERENCE STANDARDS

A. 47 CFR 15 - Radio Frequency Devices; current edition.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NECA 303 - Standard for Installing Closed- Circuit Television (CCTV) Systems; 2005.
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. System shall be RoHS (Restriction of Hazardous Substances) compliant and meet proposed amendments to the reduction of toxic substances in manufacturing in stated in the Environmental Design of Electrical Equipment Act (EDEE).
F. Installation shall comply with NECA 1-2010 “Standard Practice of Good Workmanship in Electrical Construction”
G. Installation shall comply with NEC/NFPA 70E “Standard for Electrical Safety in the Workplace”
H. Electronic data exchange between Video Surveillance System and the Access Control System shall comply with SIA TVAC
I. Installation shall comply with FCC CFR 47 Part 15 Class A “Telecommunications, Radio, Frequency, Digital Device Emission:
J. Installation shall comply with Federal, State, and Local Codes and Authority Having Jurisdiction (AHJ).
K. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of cameras with structural members, ductwork, piping, equipment, luminaires, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
2. Coordinate the work with other installers to provide power for cameras and equipment at required locations.
3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meetings:

1. Conduct meeting with facility representative to review camera and equipment locations and camera field of view objectives.
2. Conduct meeting with facility representative and other related equipment manufacturers to discuss video surveillance system interface requirements.

C. Confidentiality of Documents

1. The project documents, consisting of all technical proposals, drawings, specifications, shop drawings, as-built drawings, manufacturer’s literature, etc., shall be considered proprietary information and are to be treated with complete confidentiality. Dissemination of any security system documentation to any party not considered “need-to-know” without a pre-defined and approved agreement will be considered a violation of the contract documents and all pursuant clauses regarding financial penalties, project termination, and/or legal prosecution will apply. The Contractor is to obtain a list of “need-to-know” parties from the Owner and/or Construction Manager.
2. Use of the Contract drawings and specifications is restricted to the original site for which they were prepared. Publication therefore is expressly limited to such use. Re-use, reproduction, storage by any medium or publication by any method in whole or in part is prohibited. Visual contact with the Contract drawings and specifications constitutes prima facie evidence of the acceptance of these restrictions. Unlawful publication, dissemination, and use of these documents carry significant liability and the Owner maintains the right to legally pursue restitution and/or penalty for violation of these confidentiality conditions.

3. All documents marked “DO NOT DUPLICATE” are to be returned to the Construction Manager for proper disposal and handling upon completion of their relevant use.

1.6 SUBMITTALS

A. See Division 01 – Administrative Requirements for submittal procedures.
B. Evidence of Qualifications for Installer:

1. The Contractor shall be a bona fide security systems contractor, licensed by the State of Connecticut for the installation of the low voltage security and signal communication systems, and engaged in security system maintenance, service and contracting for at least the last five years.
2. The Contractor shall employ technicians who have been trained by the Manufacturer specified within this section to install the systems of this Manufacturer.
3. The contractor shall be a factory authorized stocking distributor of the manufacturer of the equipment included in the system so that immediate replacement parts can be made from inventory and service provided as needed on an emergency basis.
4. The Contractor shall submit with the bid a manufacturer’s certificate of acceptance of the qualifications of the Installing Contractor to install, test, maintain and repair the manufacturer’s equipment.
5. In order for the Security Consultant to verify that they meet the competency requirements of this specification, Contractors must submit the following information if so requested:

    a. Proof that the Contractor has installed, services and maintained similar security systems for a minimum of ten (10) years.
    b. Proof that the Contractor is a firm which currently and regularly installs, services and maintains security systems as a full time business.
    c. The names and qualifications of security system technicians that shall perform and supervise the work, and perform tests or adjustments on the systems and equipment. Qualifications shall include all schooling, training, and history of work experience.
    d. A list of four prior systems comparable to the one specified under this contract which were installed, serviced, and maintained satisfactorily by the Contractor for a minimum of one (1) year. Each system listed shall include the firm or owner, location, person to contact (with telephone number), date of installation and service period, and a brief description of the system and work performed on the system.

6. The Contractor shall submit any other information required by the Security Consultant to determine the competency of the Contractor. If this information is not submitted as requested, it shall be submitted within the time specified by the Architect after the bid opening. If the Contractor fails to submit the information in accordance with the Security Consultant’s request, the Contractor shall be declared non-responsive, and may be rejected to perform the work specified within this section.
7. Unit Prices:

    a. Contractor shall submit unit pricing, on the project Bid Form, stating the unit price for all materials, items, work and construction.
    b. Contractor shall provide prices for the addition of, or the elimination of, the following components for the project by identifying the additive or deductive price for each. Prices shall include labor and materials to furnish and install, test, and integrate into the system, provide the specified documentation and as-built drawings and manuals, and required training. Where conduit and wire connections are required, include 100’ of necessary cables, conduit, and interconnections. The Contractor acknowledges

that should conditions make it necessary to revise the scope of the project, the following unit price itemization will serve as the basis for adjustments to the Contract Price.

c. Fixed Interior 5MP Dome Camera $[_____]
d. Fixed Exterior 5MP Dome Camera - Pendant Mount $[_____]
e. Fixed Exterior MultiSensor Dome Camera - Pendant Mount $[_____]
f. Fixed Exterior MultiSensor Dome Camera - Pole Mount $[_____]

C. Design Data: Standby battery/UPS Calculations
D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instruction for storage, handling, protection, examination, preparation, installation, and operation of product.
E. Manufacturer's detailed field-testing procedures.
F. Maintenance contracts.
G. Product Data: Provide details and technical specifications for each product indicated. Include physical dimensions, features, performance, electrical characteristics, ratings, software versions, and operating system details.
H. Shop Drawings:

1. General: General: Bid documents, including drawings, details and specifications are considered conceptual in nature, and provide direction on products and project requirements. Contractor is given a choice of methods that may be incorporated into the system. These choices may affect the overall design, configuration and installation of the proposed system.
2. Contractor Responsibility: Prepare and submit shop drawings, rendered in the latest AutoCAD DWG file format, which show details of all work to ensure proper installation of the work using those materials and equipment specified or allowed under the approved plans and specifications. A complete Shop Drawing submittal drawing package shall consist of Drawings, Equipment Data Sheet Submittals, and an Acceptance Testing Plan.
3. Completeness: The Equipment Submittals, Acceptance Testing Plan, and the Shop Drawings should be submitted as a complete and contiguous package. Partial or unmarked submittals will not be accepted for review.
4. Scheduling: A schedule of shop drawing submissions shall be submitted for the Architect and Owner's Representative review on a form acceptable to the Architect within ten (10) days after award of the Contract. The schedule of shop drawing submissions shall include as a minimum, but not limited to the requirements stated herein.
5. Requirements: Provide the following information complete, and in the manner described herein:

a. Hardware, Application Software, and Network Requirements: A system description including analysis and calculations used in sizing equipment required by the security systems. The description shall show how the equipment will operate as a system to meet the performance requirements of the systems. The following information shall be supplied as a minimum:

1) Server(s) processor(s), disk space and memory size
2) Workstation(s) processor(s), disk space and memory size
3) Description of facility (field) control equipment (Controllers/Field Panels, Models) and their configuration
4) Operating System(s) Software, where software is provided or upgraded
5) Application Software, with Optional and Custom Software Modules supplied in this project
6) Integration Schemes: Proposed connectivity, software, development requirements, and SDK information, for inter-system communication.

7) Network bandwidth and reliability requirements
8) Number and location of LAN ports required
9) Other specific network requirements, preferences, and constraints
10) Backup/archive system size and configuration
11) Start-up operations
12) System power requirements and Uninterruptible Power Supply (UPS) sizing
13) Device/component environmental requirements (cooling and/or heating parameters)

b. Shop Drawings: Shop Drawings shall be numbered consecutively and shall accurately and distinctly present the following information:

1) Title Sheet
2) Floor Plans: Showing devices, pull boxes, cabinets, conduits and conductors in their proposed locations with device numbering scheme.
3) Riser Diagram: Showing all conduit relationships between devices shown on the Floor Plans. Show all power sources.
4) Single-Line/Block Diagrams: Show signal relationships of controls and devices within the system.
5) Custom Assembly Diagrams: For each custom assembly such as Access Control Terminal Cabinets, receptacle assemblies, or door control panels, provide an assembly drawing illustrating the appearance of the assembled device. Include dimensions, assembly components, and functional attributes (momentary or alternate action switch, lens color, panel finish)
6) Component Connection Diagrams

(a) For each equipment component such as a computer, video switcher, camera or video recorder, show the rear elevation of the device and all connectors/terminations as a pictorial.
(b) Show the wire designations on connectors. Typical wiring detail where multiple of same device is provided.
(c) Show a schedule of the wire colors connected to the pins on each device connector.

c. Equipment Wiring Diagrams

1) Show a pictorial illustration of each equipment enclosure and/or terminal cabinet, including terminals, components and wiring devices.
2) Show the device nomenclature exactly as shown on the single line diagrams.
3) Terminations: Show every termination and terminating cable, with applicable cable and wire numbers matching the single line diagrams.

(a) Every termination in the system must be documented.
(b) Termination information may be rendered as a wiring list(s), if properly coordinated with, and referenced to, typical component and single-line diagrams. Otherwise, the Shop Drawings shall show a pictorial of every component in the system, with its terminations.

4) Show wire colors for each terminal.
5) For each wire exiting the enclosure, show the destination of the wire by floor, room number and the drawing number of the panel where the wire terminates.
6) Provide working dimensions and erection dimensions.

7) Arrangements and sectional views
8) Necessary details, including complete information for making connections between work under this Contract, existing work, and work under other Contracts.
9) Stock or standard drawings will not be accepted for review unless full identification and supplementary information is shown thereon in ink or typewritten form.
10) Duplicate of design drawings may be used where each sheet is modified to reflect contractor coordination, specific requirements of the project and multidiscipline conditions.
11) Each Drawing or page shall include:

(a) Project name, Project Number and descriptions.
(b) Submittal date and space for revision dates.
(c) Identification of equipment, product or material.
(d) Name of Contractor and Subcontractor.
(e) Name of Supplier and Manufacturer.
(f) Relation to adjacent structure of material.
(g) Physical dimensions clearly identified.
(h) ASTM and Specifications references.
(i) Identification of deviations from the Contract Documents.
(j) Contractor's stamp, initialed or signed, dated and certifying to review of submittal, certification of field measurements and compliance with Contract.
(k) Location at which the equipment or materials are to be installed. Location shall mean both physical location and location relative to other connected or attached material.

d. Equipment Submittals

1) Provide a Title Page, with project name, Contractor’s name and address, contact information, date of submission, and submission revision number.
2) Provide a Parts List, for proposed equipment, materials, components and devices, listing the following information for each line item:

(a) The system type
(b) Model number
(c) Specification sheet page reference

3) Provide Manufacturers Specification Sheet with descriptive information for equipment, materials, components and devices. Number each page, to correspond with the Parts List.
4) Clearly delineate (with highlighter, arrow, or underline) on each specification sheet, specific model numbers, options and configurations being proposed for this project.
5) Indicate kinds of materials and finishes for equipment where more than one option is presented.

e. Acceptance Testing Plan

1) Submit a written document detailing the test procedures to be followed in evaluating and proving the installed system(s).

2) Provide a sample of the test forms to be used for each system and for each component of each system.
3) Include all tests required by the equipment manufacturer and by this Specification

f. Spare Parts List: Submit a list of recommended spare parts for Owner's review & approval and/or amending. Spare parts shall comprise a minimum of 5% or minimum of 2 each of field devices, device termination boards and a minimum of 1 system controller boards.

g. Incomplete or unchecked submittals which do not contain complete data on the work and full information on related matters will be returned for correction.

h. Verification: The contractor shall check and acknowledge all shop drawings and shall place his signature on all shop drawings submitted for approval. Contractor's signature shall constitute a representation that all quantities, dimensions, field construction criteria, materials, catalog numbers, performance criteria and similar data have been verified and that, in his opinion, the submittal fully meets the requirements of the Contract Documents.

i. Timeliness: The Contractor shall schedule, prepare and submit a complete shop drawing assembly in accordance with a time-table that will allow his suppliers and manufacturers sufficient time to fabricate, manufacture, inspect test and deliver their respective products to the project site in a timely manner so as to not delay the complete performance of the work.

j. Departure from Contract Requirements: If shop drawings show departures from the Contract requirements, the Contractor shall make specific mention thereof in his letter of transmittal, otherwise review of such submittals shall not constitute review of the departure. Review of the drawings shall constitute review of the specific subject matter for which the drawings were submitted and not of any other structure, materials, equipment, or apparatus shown on the drawings.

k. Contractor Responsibility: The review of shop drawings will be general and shall not relieve the Contractor of responsibility for the accuracy of such drawings, nor for the proper fitting and construction of the work, nor for the furnishing of materials or work required by the Contract. No construction called for by shop drawings shall be initiated until such drawings have been reviewed and approved.

l. Shop Drawing Submittal Review: The procedure in seeking review of the shop drawings shall be as follows:

1) The Contractor shall submit four (4) complete sets and/or electronic PDFs of shop drawings with equipment submittals and other descriptive data with one copy of a letter of transmittal to the Architect for review thirty (30) working days after award of the contract. The letter of transmittal shall contain the project name, DCAMM's Project Number, the name of the Contractor, the list of drawings submitted including numbers and titles, requests for any review of departures from the contract requirements and any other pertinent information. Drawings submitted for review shall be full-sized and included with the equipment submittals.
2) Drawings or descriptive data will be stamped "Reviewed", "Furnish as Corrected", "Revise and Resubmit", "Rejected" or 'Submit Specific Item' and one copy with a Letter of Transmittal will be transmitted to the Contractor with the return of submitted documents.
3) If a shop drawing or data is stamped "Reviewed" or "Furnish as Corrected", no additional submittal is required for that shop drawing.
4) If a shop drawing or data is stamped "Revise and Resubmit" or "Rejected", the Contractor shall make the necessary corrections and resubmit the documents as required above. The letter transmitting corrected documents shall indicate that the documents are re-submittals.

5) The Contractor shall revise and resubmit the shop drawing as required, until they are stamped either "Reviewed" or "Furnish as Corrected."

I. Equipment and Software List: Include every piece of equipment and software by product/model name and/or number, manufacturer, serial number, revision number, location, and date of original installation. If factory and/or bench testing regimens are required by the project plan, add pretesting record of each piece of equipment and software, listing name of person testing, date of test, and adjustments made.
J. CE and FCC Compliance Certificates:
K. Field quality-control reports
L. Current Specified Manufacturer Integrator Certification Letter
M. Current Specified Manufacturer Training Certificates (listing expiration dates) for Two technicians from the supporting office
N. Warranty: Software support and warranty information for all components, including Service Level Agreement (SLA) details, and duration of agreement from date of system acceptance by Owner. Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
O. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.
P. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.
2. General: The Contractor is responsible for providing accurate drawings and equipment manuals describing and depicting the systems as they are actually installed and operated.
3. Phase One: Notwithstanding requirements specified elsewhere, submit the following labeled as the "Operating and Maintenance Manual" within thirty (30) days after Final Acceptance of the Installation:

a. Record Drawings: Submit two (2) copies of revised versions of drawings as submitted in the "Shop and Field" and "Equipment Wiring Diagrams" Submittals showing actual device locations, conduit routing, wiring and relationships as they were constructed. Include nomenclature showing as-built wire designations and colors. Drawings shall include room numbers coinciding with Owner space planning numbering. Drawings shall be submitted in electronic editable AutoCAD files, in ".dwg" format, on CD or DVD disks.
b. Manuals: Submit two (2) copies of each of the following materials in bound manuals, or electronic PDF copies on CD/DVD discs, with labeled dividers:

1) A final Bill of Material for each system.
2) Equipment Instruction Manuals: Complete, project specific comprehensive instructions for the operation of devices and equipment provided as part of this work.
3) Manufacturers Instruction Manuals: Specification sheets, brochures, Operation Manuals and service sheets published by the manufacturers of the components, devices and equipment provided.
4) Include information for testing, repair, troubleshooting, assembly, disassembly and recommended maintenance intervals.
5) Provide a replacement parts list with current prices. Include list of recommended spare parts, tools, and instruments for testing and maintenance purpose.
6) Performance, Test and Adjustment Data: Comprehensive documentation of performance verification according to parameters specified herein.

7) Warranties: Provide an executed copy of the Warranty Agreement and copies of all manufacturers' Warranty Registration papers as described herein.

1.7 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70.
2. Applicable TIA/EIA standards.

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. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with video surveillance systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer's representative.

1. Contract maintenance office located within 100 miles (160 km) of project site.

E. Maintenance Contractor Qualifications: Same entity as installer.
F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
G. The requirements of the State Building Code and local regulations establish the minimum acceptable quality of workmanship and materials, and all work shall conform thereto unless more stringent requirements are indicated or specified herein.
H. All work shall comply with the latest editions of the codes as referenced herein.
I. Follow manufacturer's directions for articles furnished, in addition to directions shown on drawings or specified herein.
J. Protect all work, materials, and equipment from damage during process of work. Replace all damaged or defective work, materials and equipment without additional cost to the Owner.
K. All equipment and materials for permanent installation shall be the products of recognized manufacturers and shall be new.
L. Equipment and materials shall:

1. Where normally subject to Underwriters Laboratory Inc. listing or labeling services, be so listed or labeled.
2. Be without blemish or defect.
3. Not be used for temporary purposes.
4. Be in accordance with the latest applicable NEMA standards.
5. Be products which will meet with the acceptance of all authorities having jurisdiction over the work. Where such acceptance is contingent upon having the products examined, tested and certified by Underwriters or another recognized testing laboratory, the product shall be so examined, tested and certified.

M. Except for conduit, conduit fittings, outlet boxes, wire and cable, all items of equipment or material of one generic type shall be the product of one manufacturer throughout.
N. For items which are to be installed but not purchased as part of the electrical work, the electrical work shall include:

1. The coordination of their delivery.
2. Their unloading from delivery trucks driven into any point on the property line at grade level.
3. Their safe handling and field storage up to the time of permanent placement in the project.
4. The correction of any damage, defacement or corrosion to which they may have been subjected. Replacement, if necessary, shall be coordinated with Contractor who originally purchased the item.
5. Their field make up and internal wiring as may be necessary for their proper operation.
6. Their mounting in place including the purchase and installation of all dunnage, supporting members, and fastenings necessary to adapt them to architectural and structural conditions.
7. Their connection to building wiring including the purchase and installation of all termination junction boxes necessary to adapt and connect them to this wiring. Included also shall be the purchase and installation of any substitute lugs or other wiring terminations as may be necessary to adapt their terminals to the building wiring as called for and to the connection methods set forth in these specifications.

O. Items which are to be installed but not purchased as part of the electric work shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the electric work will be considered only if presented in writing within one week of the date of delivery to the project of the items in question. The work includes all procedures, regardless of how extensive, necessary to put into satisfactory operation, all items for which no claims have been submitted as outlined above.

P. Seismic Performance: Provide equipment capable of withstanding the effects of earthquake motions determined according to ASCE/SEI 7 and current building codes for the state of CT.

1. The term “withstand” means “the system(s) will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event.”

1.8 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Interior, Controlled Environment: System components installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F (2 to 50 deg C) dry bulb and twenty to ninety percent (20-90%) relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
2. Interior, Uncontrolled Environment: System components installed in non- temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and twenty to ninety percent (20-90%) relative humidity, noncondensing. Use NEMA 250, Type 3R enclosures.
3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and twenty to ninety percent (20-90%) relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick. Use sufficiently rated NEMA 250 enclosures.
4. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.

5. Corrosive Environment: System components subject to corrosive fumes, vapors, and wind-driven salt spray in coastal zones. Use sufficiently rated NEMA 250 enclosures.
6. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and NECA 303.
B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.10 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.11 WARRANTY

A. See Division 01 – Closeout Submittals for additional warranty requirements.
B. The Integrator guarantees the Systems to be installed under this specification to be free from any defects in workmanship and materials for a period of one (1) year from the date of final completion/acceptance of the project by the Owner as evidenced by the date of final payment for the work. The Contractor shall promptly and at their own expense remedy any defects in the work and pay for any damage to other work resulting thereof, which shall appear during the period of time covered by this guarantee. Neither the final certificate of payment nor any provisions in this Agreement shall constitute an acceptance of work not done in accordance with this specification or relieve the Contractor of liability with respect to any expressed warranties or guarantees or responsibility for faulty materials or workmanship.
C. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of equipment related to the Access Control System, and control-station equipment that fail in materials or workmanship within specified warranty period.

    1. Warranty Period: The standard manufacturer’s warranty shall apply or a minimum of a one (1) year warranty from the date of Substantial Completion.

D. The Integrator shall provide all services required to maintain the system in an operational state as specified by the manufacturer for a period of one (1) year after acceptance.
E. Service response shall be within twelve (12) hours of the initial request for service and shall be provided twenty-four (24) hours per day, seven (7) days per week and three hundred sixty-five (365) days per year.
F. Contractor shall include, as part of this warranty, a program for maintenance for each integrated system.

    1. Provide details of coverage, preventive maintenance schedules, exclusions and service rates for all billable time and travel charges.
    2. Maintenance shall include two (2) semi-annual inspections and tests to verify the intended operation of the security system(s). System testing shall include but not be limited to the testing of all devises, fault modes and batteries. A detailed test report indicating these results and any corrective measures shall be furnished to the owner.

G. The Contractor shall provide software and firmware upgrades as required and available to the Owner.
H. Submit manufacturer's standard warranties.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. Furnish and install Video Surveillance System consisting of required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
B. The awarded contractor of this section shall furnish and install a network Video Surveillance (VSS) system into this facility using electronic security devices. This integrated VSS shall incorporate all devices necessary to achieve the specified system, all associated monitoring and recording software, hardware, configuration, testing and training.
C. The contractor awarded this project must include the following licenses and configuration:

    1. VSS licenses for each camera on the Specified Access Control System

D. The contractor shall provide a rack mounted UPS for each equipment rack provided for powering all equipment located within the equipment rack. The UPS shall be supplied with an auto-shutdown feature to allow an automatic orderly shutdown of the connected server. The auto-shutdown feature shall be connected to and programmed to shut down any servers contained within the equipment rack being powered from the UPS.
E. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
F. This VSS described within this specification shall be fully integrated with the Access Control and Intrusion Detection System.
G. All installation, peripheral devices, required licensing and configurations are required as part of this specification to establish a coherent, functional system as described within this bid package.
H. Security Ethernet cabling from the indicated Telecommunication Rooms to the Specified Cameras as described within the documents shall be furnished and installed by the contractor awarded Division 27.
I. Any and all additional interconnection cabling required for a functional system shall be furnished and installed by the contractor awarded this portion of work.
J. Final terminations to all devices are required by the Contractor awarded this Section.
K. The Contractor awarded this Section shall furnish and install a complete integrated security system and all associated, terminations, supporting devices, configuration of system, testing and training in accordance with this Bid package.
L. This specification is used to identify the requirements for an integrated VSS. The operator workstation(s) shall be used for database programming and storage of historical events and as a User interface with the Access Control System.
M. Within the VMS, the Contractor shall create floor plan maps that include camera icons appropriately placed according to actual location. Upon clicking a camera icon, the video feed associated with that camera shall automatically be called up and displayed.
N. System Design Intent:

    1. It is the intention of this system design to provide a fully functional Video Surveillance System for, minimally, the following features:

a. The end user shall be able to access live or recorded video from within the VSS software and shall have the following capabilities:

1) The end user shall have the ability to pause, stop, resume, fast forward, frame advance, rewind, and move to a different time window.
2) The user shall be able to quickly switch between live and recorded video.
3) The user shall be able to view multiple video feeds simultaneously.
4) Upon alarm input to the IDS or ACS, a predetermined video feed or feeds that are associated with that alarm shall automatically display in the Access Control System Software window. This video window shall have the capability to display recorded (IE 10 seconds prior to alarm) video.
5) Within the VSS software window, the end user shall have the ability to call up and display live video from any camera. This shall include the ability to display multiple live camera views simultaneously through a matrix view.
6) Within the VMS, the end user shall have the ability to export recorded video to a local hard drive or to a removable media (such as CD or USB drive). The system shall automatically watermark this video file for future proof of authenticity.

O. System Functionality Overview:

1. System shall provide high-quality delivery and processing of IP-based video and control data using standard Ethernet-based networks.
2. System shall have seamless integration of all video surveillance and control functions.
3. Graphical user interface software shall manage all IP-based video matrix switching and camera control functions and recording and archive/retrieval management. IP system shall also be capable of integrating into larger system environments.
4. System design shall include all necessary compression software for high-performance, dual-stream, Motion JPEG and H.264 video.
5. All camera signals shall be compressed to H.264, encoded, and delivered onto the network for processing and control by the IP video-management software.
6. Camera system units shall be ruggedly built and designed for extreme adverse environments, complying with NEMA Type environmental standards.
7. The Camera's recorded images shall include masking of the unwanted areas within each camera view to minimize storage space. These recorded images shall be defined with the Owner and technology consultant.
8. Configuration of the Video Server to utilize two (2) Ethernet connections and Network Interface cards; one (1) for incoming video and recording and one (1) to send recorded video to the storage device.
9. Video management software shall be configured for the following.

a. Recorded Video Compression Rate: H.264
b. Frame Recorded Per Second: Fifteen (15).
c. Resolution should be set at the highest obtainable from each camera specified.
d. Stored data shall be saved for thirty (30) calendar days.
e. Interior cameras shall record eighteen (18) hours per day.
f. Exterior cameras shall record twenty-four (24) hours per day.
g. Include 10% headroom storage.
h. Include subtotal for processing and management software.
i. Each camera "Field of View" shall be coordinated with the assistance of the Owner and/or the Security Consultant.

P. System Configuration Overview:

1. All system configuration(s) shall be included to attain a fully functional system and shall be within the Scope of work of the awarded Contractor of this section. This configuration shall include but not be limited to the following:

    a. Configuration of all cameras to be managed via the Video Management software.
    b. Configuration of Video Surveillance Server to view/record/access all cameras.
    c. Configuration of the Video Surveillance Servers to monitor all connected cameras for video loss. Video loss detection shall create an alarm on the VMS, alert any connected workstation, and simultaneously send an email to the system administrator conveying the video loss condition.
    d. Configuration of video storage devices with the server.
    e. Configuration of Browser Based Client for up to (4) users groups.
    f. Configuration of the Video Storage Server per the manufacturer's established best practices.
    g. Configuration of the Video Management Server per the manufacturer's established best practices.
    h. Configuration of the Video Mobile Server per the manufacturer's established best practices.
    i. Integration with the Owner's Active Directory.
    j. Configuration of LAN switches – Active Electronics, as related to the systems specified within this document. Including VLANS and IP addressing shall be as indicated by the Owner.
    k. The Contractor shall coordinate any/all network connections with the Owner IT Department prior to making any physical connections to the Owner's network components. Failure to follow this directive may result in expenditures for repair and troubleshooting by the Owner's IT department or 3rd party IT contractor/vendor. Such expenditures to remedy any issues caused by incorrect coordination by the Contractor shall be borne by the Contractor.
    l. The contractor will be responsible for establishing the security of all IP devices, servers, and VMS storage from adversary compromise (internal or external) in conjunction with the owner's IT Department.
    m. The cost of investigation, repairs, and reprogramming resulting from any security breaches during the construction or operation of the systems (while under warranty or service agreement) attributable to the failure of the Contractor to implement approved IT security measures shall be borne by the contractor.
    n. Configuration of the VMS and Access Control managed software to:

        1) Allow complete interface between both platforms
        2) Allow the Access Control System to access and view all video surveillance cameras.
        3) Allow access and controlled network management system with Web and Internet access of the Video Surveillance system.

    o. Programming camera names and recording parameters to optimize the camera for the environment for which it is operating in. Camera names shall be coordinated with the Owner prior to configuration. Naming all cameras within the system is the responsibility of the Contractor.

Q. Environmental Conditions: System(s) shall withstand the environmental conditions without mechanical or electrical failure, damage or degradation of its operating capacity Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Interior, Controlled Environment: System components installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F (2 to 50 deg C) dry bulb and twenty to ninety percent (20-90%) relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
2. Interior, Uncontrolled Environment: System components installed in non- temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and twenty to ninety percent (20-90%) relative humidity, noncondensing. Use NEMA 250, Type 3R enclosures.
3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and twenty to ninety percent (20-90%) relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick. Use sufficiently rated NEMA 250 enclosures.
4. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
5. Corrosive Environment: System components subject to corrosive fumes, vapors, and wind-driven salt spray in coastal zones. Use sufficiently rated NEMA 250 enclosures.
6. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

2.2 VIDEO SURVEILLANCE CAMERA

A. Video Surveillance cameras basis of design shall be AXIS Communications
B. Approved Alternates:

    1. Hanwha AI Series
    2. Bosch Starlite Series

C. Exterior 7' - 10' AFF Camera Basis of Design: AXIS P3267-LVE

    1. QTY: Per Drawings

D. Exterior 10' - 12' AFF Camera Basis of Design: AXIS P3719-PLE

    1. QTY: Per Drawings

E. Interior Camera Basis of Design: AXIS P3267-LV

    1. QTY: Per Drawings

2.3 VIDEO MANAGEMENT SYSTEM

A. The video management system shall be Milestone Corporate - Latest Version
B. Alternates shall not be accepted.
C. Include device licenses for all cameras and devices for a fully functional system.
D. Include all licenses for integration with Access Control System

2.4 VIDEO RECORDING SERVER

A. The video recording server basis of design shall be Seneca Balto R4
B. The server shall be sized per direction of this specification.
C. Approved Alternate Server Manufacturers:

    1. BCDVIDEO
    2. DELL

D. The contractor must submit server calculations with the product submittal. Calculations must be performed by the server manufacturer and on manufacturer letterhead.

2.5 VIDEO MANAGMENT SERVER

A. The video management server basis of design shall be Seneca Balto M3
B. Approved Alternate Server Manufacturers:

    1. BCDVIDEO
    2. DELL

2.6 UNINTERRUPTIBLE POWER SUPPLY (UPS):

A. The Contractor shall supply individual UPS' each Telecommunication Room or Equipment Room where Active Electronics supplying data and signal to the Video Surveillance System is located. The UPS will be used to support Ethernet switch, servers, video recorders, and any other rack mount security equipment.
B. The Contractor shall supply individual UPS at security guard post. UPS will be used to support security workstation, monitors, printer, intercom master station, and any other security equipment in that location.
C. The UPS shall be as manufactured by APC or approved equal
D. The supplied UPS shall support the equipment at each location plus an additional 500 Watts at 120VAC for a minimum of fifteen (15) minutes under full load
E. The Contractor shall supply the appropriately sized UPS as dictated by the accepted submitted equipment as approved by the Engineer.
F. The UPS located in ER / TR locations shall be rack mountable and shall include all mounting hardware.
G. The UPS shall have the capability of sending SMTP email messages
H. The UPS shall be supplied with software to connect to the security system Ethernet network to allow for monitoring and alarm condition of the UPS including but not limited to the following;

    1. UPS on battery
    2. UPS load capacity exceeded
    3. UPS off line
    4. UPS overheat
    5. UPS experienced surge

2.7 SURGE PROTECTION:

A. Install Lightning / Surge protection for all exterior rated cameras. Ground all protectors to manufacturer recommendations and Code requirements.

B. The intent of the Lightning / Surge protector is to protect the connected electronics (switches, routers, servers) in the event a camera is struck by lightning.
C. Surge protectors shall be installed between camera and patch panel.
D. Acceptable manufacturers:

1. Ditek
2. Approved Equivalent

2.8 CLIENT WORKSTATIONS:

A. Client Viewing PC:

1. Seneca Balto C2

B. Wireless Mouse and Keyboard:

1. IOGEAR #GKM552R
2. Approved Equivalent

C. 55” Display and Mount:

1. SAMSUNG #QB55R or approved equal
2. The digital display shall meet the following requirements:

a. 55” diagonal
b. 3840 x 2160 minimal resolution
c. 500 nit minimal brightness
d. Approved for 24/7 operation
e. Includes a standard manufacturer 3-year warranty

3. CHIEF #MTM1U or approved equal
4. Include Chief #FHB5147 Universal Flat Panel Mount Hardware Kit

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that ratings and configurations of system components are consisted with the indicated requirements.
C. Verify that mounting surfaces are ready to receive the system components.
D. Verify that branch circuit wiring is installed, completed, tested, and ready for connection to system.
E. Verify that conditions are satisfactory prior to starting work.
F. Device Locations

1. All device locations are to be field verified with the Owner prior to start of project. Architectural drawings are for approximation purposes only. Additional charges will not be allowed for outlet installation in areas not reviewed or approved by the Owner.

G. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.
H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install Video Surveillance system in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Install cameras level and plumb.
D. Install cameras with 84-inch minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.
E. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms and adjust.
F. Install power supplies and other auxiliary components within the Telecommunication Room unless otherwise indicated.
G. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.
H. Identify system components, wiring, cabling, and terminals according to industry standards.
I. Unless otherwise indicated, use wiring in conduit.

1. Use suitable listed cables in we locations, including underground raceways.
2. Use suitable listed cables for vertical wire applications.
3. All cabling shall be plenum rated.
4. Install wiring in conduit for the following:

    a. Where required for rough-in.
    b. Where required by the AHJ.
    c. Where exposed to damage.
    d. Where installed outside the building.
    e. For exposed connections from outlet boxes to devices.

5. Conduit: comply with Division 27 0528
6. Conceal cables unless specifically indicated to be exposed.
7. User power transfer hinges specified within Division 08 for concealed connections to door hardware.
8. Cables in the following areas may be exposed:

    a. Equipment Closets

9. Route exposed cables in parallel or perpendicular to building structural members and surfaces.
10. Do not exceed manufacturer's recommended maximum cable length between components.

J. Provide grounding and bonding in accordance with Division 26.

K. Install firestopping to preserve the fire resistance rating of partitions and other elements, using materials and methods specified in Division 07.
L. Install power supplies and other auxiliary components at control stations unless otherwise indicated.
M. Identify system components, wiring, cabling, and terminals according to ANSI/EIA/TIA standards.
N. Security System Integration

1. The Contractor shall be responsible for providing hardware and software interfaces to achieve the specified system performance described herein and, by reference, realize absolute and seamless compatibility with the related component systems.
2. The Contractor shall ensure system additions and modifications provided under this scope of work have no negative effect on the individual components and systems, and their core functionality, and no permanent effect beyond that specified or implied by the scope of work.
3. Purpose

a. Integration is the process of designing, deploying, and configuring independently operating systems with the ability to request, receive, extract, process, and act upon information from other systems.
b. Successful system integration must address three fundamental issues:

1) Functionality: What information is needed, how it is to be requested and processed, and what functions or activities need to occur upon receipt of the information.
2) Connectivity: How systems will be connected to support the communication of information and commands. (Special interfaces, wiring, networks, databases.)
3) Communication: How information will be communicated between systems. (Instruction sets, language, protocols, formats, priority.)

4. Environment

a. Integration components shall generally comprise special elements of independent subsystems, and shall be located within, or in close proximity to, the processing components of each independent subsystem. Where subsystems require special hardware or communications interfaces to support integration, the special hardware should be located near the independent subsystem processing components or network appliance, based on the manufacturers' recommendation. See the drawings for details on mounting locations.
b. Central Administrative Post: Components of the main integration system operating shell may be distributed throughout the site / facility, in relation to the other integrated subsystems. The main EACS system monitoring occurs in the Massachusetts State House building Primary Security Operations Center (SOC – room 013A-1). System programming, rules configuration, and control shall occur either at this location or at another location designated by the Owner.

5. Infrastructure and Connectivity:

a. Devices/Appliances: Appliances and devices shall be connected to their respective systems via the applicable communications network.

b. System LAN/WAN Connectivity: System Servers and microprocessor-based Control Panels, shall reside on the Local Area Network (LAN) or Wide Area Network (WAN) tier designated for integrated components.
c. Enterprise: LAN networks will be connected to the Wide Area Network, to establish connectivity between remote sites and both the Primary and Alternate Security Operations Center (SOC – room SB05-1).

6. Attributes

a. The attributes of the integrated environment are primarily defined by the subsystems that are to be integrated. Verify existing system components to be expanded by this project.
b. Integrated systems comprise the processors, software, electrical control panels, data gathering panels, special data interfaces, and converters required to allow systems to communicate with each other, process information, and allow users to program and perform operations.

7. Functions

a. The system shall provide the following automated processing rules, at a minimum:
b. The object of “Access Control system integration” is to automatically configure the system to display, record, and report appropriate system activity to various elements of the system. Automatic configuration can free operators from difficult control tasks, give the operator more time to respond to events, reduce operator error, and ensure critical system tasks occur consistently.
c. Electronic Access Control system elements shall be electronically integrated in such a way as to enable detection, database records and/or event-initiated instructions to be communicated between system components, to initiate recording, display, communication, and control activities.
d. Event-Initiated Interface, General:

1) The system shall support the capability to send and receive alarm and control messages between the Access Control System and video systems via a LAN communications link, using API, XML, or other industry-standard communication languages and formats, and shall act upon those messages received.
2) The system shall support the capability to send and receive alarm and control messages and alarm signal between the Access Control system and Intrusion Detection System for lockdown / duress / and panic button initiation.
3) Where integration may require the implementation of data interfaces, Contractor shall propose such integration to the Owner for approval, before proceeding with the work.
4) Software routines required to accomplish the required data-interface with external equipment and controls will be fully developed, installed, tested and supported by the Contractor.
5) The manufacturer of each applicable system will also support the data interface and will be engaged by the Contractor to provide on-site technical assistance where required to prepare, repair, configure, and test the system to operational condition.
6) Communication of event information between systems shall take place automatically and immediately when the event is sensed by the System.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: The Contractor shall engage a qualified testing agency to perform tests and inspections with the Owner and appointed project manager.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
C. Camera Field Verification:

1. All camera locations MUST to be field verified with the Owner prior to start of project. Architectural drawings are for approximation purposes only. Additional charges will not be allowed for installation in areas not reviewed or approved by the Owner.
2. Camera images will be reviewed with the Owner and the Security Consultant. The contractor shall plan for three adjustments of the camera's field of view as follows:

a. Initial setup and testing
b. Owner and / or Security Consultant adjustments #1
c. Owner and / or Security Consultant adjustments #2

D. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

E. Tests and Inspections:

1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:

a. Prepare equipment list described in "Submittals" Article.
b. Verify operation of auto-iris lenses.
c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
e. Set and name all preset positions; consult Owner's personnel.
f. Set sensitivity of motion detection.
g. Connect and verify responses to alarms.
h. Verify operation of control-station equipment.

3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least fourteen (14) days. Provide a minimum of ten (10) days notice of test schedule.

4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

F. Video Surveillance System shall be considered defective if it does not pass tests and inspections.
G. Prepare test and inspection reports.
H. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two (2) visits to this Project location during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:

1. Check cable connections.
2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
3. Adjust all preset positions; consult Owner's personnel.
4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
5. Provide a written report of adjustments and recommendations

3.4 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.
B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens before installation and prior to final acceptance.
C. Remove rubbish and debris: Installation contractor is not allowed you use the onsite dumpster and is responsible to discard their own debris off site.

3.5 CLOSEOUT ACTIVITIES

A. See Division 01 – Closeout Submittals for Closeout Submittals.
B. Demonstration: Demonstrate proper operations of system to Owner and correct deficiencies or make adjustments as directed.
C. Training:

1. By means of training classes augmented by individual instruction as necessary, the Bidding contractor shall fully instruct the BOE’s designated staff and personnel in the operation, adjustment and maintenance of all products, equipment and systems.
2. General Training Requirements:

a. The security contractor shall submit proposal to conduct training courses for the security personnel in the operation and maintenance of the security systems within this security project.
b. The security contractor shall include training manuals and aids in the quantity as requested by the Owner. The training manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. All personnel providing the instructions shall be certified by the equipment manufacturer for all applicable hardware and software.
c. Approval of the planned training content and training schedule shall be obtained by the Owner at least 45 days before the training is scheduled.

d. Training shall be provided by qualified, factory trained and certified engineers familiar with each system and its operations and shall be provided at the site for a period of no less than the hours stipulated below.

3. Training Topics:

a. System Administration Training

1) This training shall focus on determining and implementing system operational parameters.
2) The first training class shall be conducted so that it is completed approximately 30 days prior to acceptance of the system and final system reliability testing. 8 Hours of Administration training; (2) 4-hour classes.
3) The second training class shall be conducted so that it is completed approximately 7 days prior to acceptance of the system and final system testing. The system administrator shall be included as part of this final system acceptance and reliability testing. 6 Hours of training; (2) 3-hour classes.
4) This Administrations training shall include:

(a) Overall architecture and configuration of each system.
(b) Use of all system functions.
(c) ID badging design and production.
(d) Card-holder setup and configuration.
(e) Card-holder access level assignment.
(f) Access Door programming.
(g) Alarm setup and implementation.
(h) Data storage and retrieval through reports.
(i) Creation of reports.
(j) System database backup procedures.
(k) Hardware specifications.
(l) Fault diagnosis and corrections.

b. System User Monitoring Training

1) This training shall be for each designated personnel at this school.
2) This training shall focus on day-to-day system operations. Each user shall be capable to start the systems, operate them, recover the systems after a failure, and describe the specific hardware architecture and operation of the systems.
3) The first training class shall be conducted so that it is completed approximately 30 days prior to acceptance of the system and final system reliability testing. All System User Training shall be performed at each school within this specification. 8 Hours of User training; (2) 4-hour classes.
4) The second training class shall be conducted so that it is completed approximately 7 days prior to acceptance of the system and final system testing. The system administrator shall be included as part of this final system acceptance and reliability testing. 6 Hours of User training; (2) 3-hour classes.
5) Training shall include:

(a) Use of overall system monitoring functions as determined by the security administration staff.
(b) Monitoring alarm events.
(c) Monitoring personnel access into the facility.

(d) Assessing, responding to, and clearing alarms and messages.
(e) Monitoring access door status.
(f) Running routine reports.
(g) General hardware architecture.
(h) Functional operation of each system and interaction between these systems.
(i) All Operator commands.
(j) Database entry.
(k) Report generation.
(l) Alarm assessment.
(m) Simple diagnostics.

c. System Troubleshooting and Maintenance Training

1) Training shall be provided with the internal features and configuration of the security systems so the user can trouble shoot and repair most configuration and physical device problems.
2) The training class shall be conducted so that it is completed approximately 14 days prior to acceptance of the system and final reliability testing. The users shall be included as part of this reliability testing. 8 Hours of training; (2) 4-hour classes.
3) This training shall include:

(a) System networking communications and diagnostics.
(b) Device configuration and programming.
(c) Controller setup.
(d) Wiring and cabling overview.
(e) System Diagnostics.
(f) Software troubleshooting.
(g) Physical layout of each piece of hardware.
(h) Preventive maintenance procedures and schedules.
(i) Calibration procedures.

d. IT Training

1) Training shall be provided information of the security systems to the IT staff. This shall include information as to how each system functions within the LAN/WAN network infrastructures. 4 Hours of training.
2) Topics shall include:

(a) Network topologies.
(b) Maintenance of data security.

4. Training hours and sessions must be documented by the instructor and approved by the Owner before project closeout.
5. Should the training be deemed as inadequate by the Owner, the owner reserves the right to retain outside manufacturer training. If this outside manufacturer training has an associated cost, this cost shall be deducted from the final invoice of this project.
6. The Owner reserves the right to request the Contractor to videotape training sessions and turn over video records (DVD format) to Owner as part of the “Owner Project Manuals” and Deliverables.

3.6 PROTECTION

A. Protect installed system components from subsequent construction operations.

3.7 MAINTENANCE

A. See Division 01 – Execution and Closeout Requirements for additional requirements relating to maintenance service.
B. Adjustments:

1. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two (2) visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:

a. Check cable connections.
b. Check proper operation of video surveillance devices.
c. Provide a written report of adjustments and recommendations.

C. Provide to Owner, at no extra cost, a separate maintenance contract for the service and maintenance of the Access Control System for One Year from date of Substantial Completion. Include a separate description of preventative maintenance, systematic examination, cleaning, inspection, and testing, with a detailed schedule.
D. Conduct site visit at least once every three months to perform inspection, testing, and preventative maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.
E. 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 the site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION 28 2300

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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: New proprietary station operated by Owner.
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.
3. Sustainable Design Intent: Comply with project requirements intended to achieve sustainable credits, as indicated design, measured and documented according to LEED v4 BD+C construction prerequisites and credits, as indicated on the LEED v4 Matrix. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for mandatory and targeted strategies.

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 ACTION SUBMITTALS

A. LEED Submittals:
   1. One LEED Materials Reporting Form with each Product Data submittal, with supporting documentation:
      a. Environmental Product Declaration
      b. Recycled Content
      c. Health Product Declaration and/or Cradle to Cradle Certification
      d. UL Greenguard Gold Certification for paints, coatings, ceiling assemblies, wall assemblies, adhesives and sealants
      e. CRI Green Label Plus Certification for carpets and carpet padding
      f. SCS Floorscore Certification for flooring and subflooring
      g. UF/NAUF Certification for wood products
      h. FSC Chain of Custody certificate and invoices for all FSC wood products

1.7 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.

1.8 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.

1.9 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 March 2, 2022, prepared by Welti Geotechnical, P.C.

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 Study for Proposed New Prosser Library, 6 Mountain Avenue, Bloomfield, CT"). 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 <u>not</u> 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 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.
5. Sustainable Design Intent: Comply with project requirements intended to achieve sustainable credits, as indicated design, measured and documented according to LEED v4 BD+C construction prerequisites and credits, as indicated on the LEED v4 Matrix. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for mandatory and targeted strategies.

1.3 REFERENCE STANDARDS

A. CTDOT Form 818: State of Connecticut Department of Transportation Standard Specifications for Roads, Bridges, Facilities and Incidental Construction Form 818; including latest Supplements, except as noted otherwise in this Section.

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. LEED Submittals:
1. One LEED Materials Reporting Form with each Product Data submittal, with supporting documentation:
a. Environmental Product Declaration
b. Recycled Content
c. Health Product Declaration and/or Cradle to Cradle Certification
d. UL Greenguard Gold Certification for paints, coatings, ceiling assemblies, wall assemblies, adhesives and sealants
e. CRI Green Label Plus Certification for carpets and carpet padding
f. SCS Floorscore Certification for flooring and subflooring
g. UF/NAUF Certification for wood products
h. FSC Chain of Custody certificate and invoices for all FSC wood products

E. Quality Control Plan, Project Summary Sheet and Extended Season Paving Plan as identified and formatted per Form 818 and the CTDOT Advisory Team Web Page.

F. 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. The Contractor shall conform to the requirements of Form 818, Section 4.06.03-8 Contractor Quality Control (QC) Requirements.
   1. The Contractor shall perform all quality control sampling and testing, provide inspection, and exercise management control to ensure that bituminous concrete placement conforms to the requirements as outlined in its QCP during all phases of the work. The Contractor shall document these activities for each day of placement.
   2. The Owner or Owner's Representative may elect to employ a separate testing agency to confirm that certain crucial quality control procedures or requirements are met during the construction process.

B. 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.

C. 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.

D. 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.

E. 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: CTDOT FORM 818 Subarticle M.04.01-1.

C. Fine Aggregate: CTDOT FORM 818 Subarticle M.04.01-2.

D. Mineral Filler: CTDOT FORM 818 Subarticle M.04.01-3.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: CTDOT FORM 818 Subarticle M.04.01-4.

B. Emulsified Asphalts: CTDOT FORM 818 Subarticle M.04.01-5.

C. Water: Potable.

2.3 AUXILIARY MATERIALS

A. Reclaimed Asphalt Pavement (RAP) Recycle Option: CTDOT FORM 818 Subarticle M.04.01-6.

B. Joint Seal: Hot-poured rubber compound CTDOT FORM 818 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: CTDOT 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

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 (Heavy Duty) Concrete Pavement.
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. Sustainable Design Intent: Comply with project requirements intended to achieve sustainable credits, as indicated design, measured and documented according to LEED v4 BD+C construction prerequisites and credits, as indicated on the LEED v4 Matrix. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for mandatory and targeted strategies.
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 REFERENCE STANDARDS

A. CTDOT Form 818: State of Connecticut Department of Transportation Standard Specifications for Roads, Bridges, Facilities and Incidental Construction Form 818; including latest Supplements, except as noted otherwise in this Section.

1.4 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.

1.5 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.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
1. One LEED Materials Reporting Form with each Product Data submittal, with supporting documentation:
    a. Environmental Product Declaration
    b. Recycled Content
    c. Health Product Declaration and/or Cradle to Cradle Certification
    d. UL Greenguard Gold Certification for paints, coatings, ceiling assemblies, wall assemblies, adhesives and sealants
    e. CRI Green Label Plus Certification for carpets and carpet padding
    f. SCS Floorscore Certification for flooring and subflooring
    g. UF/NAUF Certification for wood products
    h. FSC Chain of Custody certificate and invoices for all FSC wood products

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: Conform to Form 818 Section 9.21 and M.03.02 PCC 04462.

C. 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 Form 818 Section M.03.02 PCC 04462.

B. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
    1. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

    1. Fly Ash or Pozzolan: 25 percent.

D. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
    1. Air Content: 6 percent plus or minus 1-1/2 percent for 1-inch (25-mm) nominal maximum aggregate size.

E. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

F. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
    1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

G. 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. Do not “picture frame” edging.

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 321400 - UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Brick pavers.
   2. Granite pavers and granite stair treads set in mortar setting beds (Add Alternate - Granite Steps)

B. Related Requirements:
   1. Section 321313 "Concrete Paving" for concrete base under unit pavers.
   2. Sustainable Design Intent: Comply with project requirements intended to achieve sustainable credits, as indicated design, measured and documented according to LEED v4 BD+C construction prerequisites and credits, as indicated on the LEED v4 Matrix. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for mandatory and targeted strategies.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site. Meeting to include the manufacturer’s representative for the polymeric sand product.

1.3 ACTION SUBMITTALS

A. Product Data:
   1. For the following:

      a. Pavers.
      b. Setting bed materials.
      c. Polymeric sand
      d. Mortar and grout materials.
      e. Edge restraints.

B. LEED Submittals:
   1. One LEED Materials Reporting Form with each Product Data submittal, with supporting documentation:
      a. Environmental Product Declaration
      b. Recycled Content
      c. Health Product Declaration and/or Cradle to Cradle Certification
      d. UL Greenguard Gold Certification for paints, coatings, ceiling assemblies, wall assemblies, adhesives and sealants
      e. CRI Green Label Plus Certification for carpets and carpet padding
      f. SCS Floorscore Certification for flooring and subflooring
      g. UF/NAUF Certification for wood products

h. FSC Chain of Custody certificate and invoices for all FSC wood products

C. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C136.

D. Samples for Initial Selection: For each type of unit paver indicated and the following:

1. Joint materials involving color selection.
2. Exposed edge restraints involving color selection.

E. Samples for Verification: For full-size units of each type of unit paver and stair tread indicated. Assemble no fewer than five Samples of each type of unit on suitable backing and grout joints. Include Samples of the following:

1. Joint materials.
2. Exposed edge restraints.

F. Shop Drawings: For paver joint patterns based on dimensions from actual paver and stair tread used on the project. Bid documents contain joint patterns based on nominal dimensions of unit pavers.

G. Adhesion and compatibility Test reports: From latex-additive manufacturer for mortar and grout containing latex additives.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.

1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C67.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified unit paving installer. Installer's field supervisor must have Concrete Paver Installer Certification from the Interlocking Concrete Pavement Institute (ICPI) with the following designation:
1. Commercial Paver Technician Designation.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

2. Minimum mock-up area to be 6’ x 6’ and include all types of paving layout including banding, field pavers and accent pavers.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store pavers 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.

D. Store liquids in tightly closed containers protected from freezing.

1.7 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.

    a. 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. Basis of Design Brick Paver Manufacturer is either Whitacre-Greer, www.wgpaver.com or Belden Brick, www.beldenbrick.com.

B. Basis of Design Granite Paver and Granite Stair Tread to conform with granite used in Section 044200 “Dimensional Stone Cladding”.

C. Source Limitations: Obtain each type of unit paver, 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 BRICK BANDING PAVERS

A. Brick Pavers, Light-Traffic Paving Brick: ASTM C902, Class SX, Type I, Application PX. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.

1. Thickness: 2-1/4 inches.
2. Face Size: 4 by 8 inches.
3. Color: As selected by Architect from manufacturer's full range.

B. Efflorescence: Brick to be rated "not effloresced" when tested according to ASTM C67.

C. Temporary Protective Coating: Precoat exposed surfaces of brick pavers with a continuous film of a temporary protective coating that is compatible with brick, mortar, and grout products and can be removed without damaging grout or brick. Do not coat unexposed brick surfaces; handle brick to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

2.3 BRICK FIELD PAVERS

A. Brick Pavers, Light-Traffic Paving Brick: ASTM C902, Class SX, Type I, Application PX. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.

1. Thickness: 2-1/4 inches.
2. Face Size: 8 by 8 inches.
3. Color: As selected by Architect from manufacturer's full range.

B. Efflorescence: Brick to be rated "not effloresced" when tested according to ASTM C67.

C. Temporary Protective Coating: Precoat exposed surfaces of brick pavers with a continuous film of a temporary protective coating that is compatible with brick, mortar, and grout products and can be removed without damaging grout or brick. Do not coat unexposed brick surfaces; handle brick to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

2.4 AGGREGATE SETTING-BED MATERIALS

A. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.

B. Drainage Geotextile: Nonwoven needle-punched geotextile fabric, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2, AASHTO M 288.
2. Apparent Opening Size: No. 40 sieve, maximum; ASTM D4751.
3. Permittivity: 0.5 per second, minimum; ASTM D4491.

4. UV Stability: 50 percent after 500 hours' exposure, ASTM D4355.

C. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

2.5 GRANITE STAIR TREADS AND PAVERS

A. Granite Shall be of hard and durable granite from same quarry, and location in quarry, and subject to the same requirements for granite stair treads and pavers, free from seams which impair its structural integrity, and a smooth slitting character. Natural color variations characteristic of the deposit will be permitted. Granite shall come from approved quarries and, when tested, shall have a French coefficient of wear of not less than 16 or a Los Angeles percentage of wear of not more than 32. Test sample shall conform to the requirements of ASTM C-422.
   1. Granite to match the sample provided by the Architect.

B. Granite Stair Treads
   1. Granite treads shall be cut to the dimensions as indicated in the Drawings.
   2. Exposed top edges shall be snapped true to dimension.
   3. Top face shall be thermal finish.
   4. Treads shall be notched as indicated in the Drawings.
   5. Treads shall have drilled holes (minimum of 2 per tread) to allow for dowel pining to concrete step base.
   6. Joint sealant and backer rod for horizontal and vertical installations to conform to Section 321313 “Concrete Paving”.

C. Granite Pavers
   1. Granite pavers shall be dimensioned as indicated in the Drawings.
   2. Exposed top edges shall be snapped true to dimension.
   3. Top face shall be thermal finish.

D. Dowel Pins
   1. Stainless steel dowels to match the sizes indicated in the Drawings.

2.6 MORTAR-BED BOND COAT

A. Provide polymer fortified, thin-set mortar for exterior installation of stone and pavers. Must be designed for exterior and underwater applications and provide superior bond to concrete.
   1. Exceed ANSI A118.4, and A118.15.

2.7 MORTAR-SETTING BED MATERIALS

A. Provide polymer fortified mortar bed containing polymers, Portland cement and graded aggregate, that does not require the addition of latex admix, for bonded and non-bonded mortar applications.
   1. Exceed ASTM C270 requirements.

B. Water: Potable.

2.8 GROUT MATERIALS

A. Polymeric sand for Joints of pavers:

1. Containing self-healing polymers to resist freeze/thaw, extreme heat, erosion, insects and weeds, with Haze free technology for cleaner installation.

a. Gator Maxx G2 Sand for paving stone joints, as manufactured by Alliance Designer Products Inc., 225 Boulevard Bellerose West, Laval, Quebec, Canada (866) 212-1611 www.alliancegator.com

b. HP NextGel Jointing Sand for Pavers, as manufactured by Techniseal, 300 Liberte Avenue, Candiac, Quebec, Canada (866) 933-3035

c. PolySweep Polymeric Sand, as manufactured by SEK Surebond, 3925 Stern Ave., St. Charles IL, USA (800) 932-3343 www.sek.us.com

2. Color as selected by Architect from manufacturer's full range including standard colors, premium colors, custom colors, exotic colors and matrices.

B. High-Performance Cement Grout: ANSI A118.7, sanded.

1. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.

2. Grout Colors: as selected by Architect from manufacturer's full range including standard colors, premium colors, custom colors, exotic colors and matrices. Water: Potable.

C. Water: Potable.

2.9 MORTAR AND GROUT MIXES

A. General: Comply with referenced standards and with manufacturer’s written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimal performance characteristics. Discard mortars and grout if they have reached their initial set before being used.

B. Packaged Grout: Proportion and mix according to grout manufacturer’s written instructions.

2.10 EDGE RESTRAINTS

A. Aluminum Edge Restraints: Manufacturer's standard extruded-aluminum edging 3/16 inch thick by 5-1/2 inches high with loops pressed from face to receive stakes at 12 inches o.c., and aluminum stakes 12 inches long for each loop.

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

a. Curv-Rite Inc.

b. Permaloc Corporation.

c. Sure-loc Edging Corporation.

B. Finish: Aluminum edge restraint and stakes to be mill finish by the manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive unit paving and stair treads, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Do not install granite stair treads, granite pavers or brick pavers until supporting cast-in-place concrete has attained minimum allowable design compressive strength and supporting steel or other structure is structurally ready to receive load from units.

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

3.2 PREPARATION

A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

D. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

E. Joint Pattern: As indicated on the plans is based on the nominal dimension of the unit paver. Submit shop drawing of joint pattern layout based on actual unit paver dimensions used.

F. Tolerances:

1. Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) or 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.

G. Expansion and Control Joints:

1. Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints. Install joint filler before

setting pavers. Sealant materials and installation are specified in Section 321313 "Concrete Pavement."

H. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
2. For metal edge restraints with top edge exposed, drive stakes at least 1 inch below top edge.

3.4 INSTALLATION – GRANITE STAIR TREADS

A. Install dowels and other accessories required for connecting granite stair treads to supporting materials.

B. Erect granite stair treads working from the bottom of the stairs to the top.

C. Install granite stair treads level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of the tread units until permanent connections are completed.

D. Install temporary spacing shims as stair tread units are being erected. Prevent shims from separating.

E. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.

F. Remove any projecting lifting devices flush with surface. No lifting devices are to be left exposed.

G. Unless otherwise indicated, maintain uniform joint widths of 1/2 inch.

H. Fill joints with backer rod and apply sealant at all joints to prevent intrusion of water between or behind treads.

3.5 AGGREGATE SETTING-BED APPLICATIONS

A. Install concrete base as per Section 32 13 13 CONCRETE PAVING. Broom finish and edging are not required.

B. Place drainage composite over concrete base.

C. Place leveling course and screed to a thickness of 25 to 38 mm (1 to 1-1/2 inches), taking care that moisture content remains constant, and density is loose and uniform until pavers are set and compacted.

D. Treat leveling course with herbicide to inhibit growth of grass and weeds.

E. Set pavers with a minimum joint width of 1/8 inch and a maximum of 1/4 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines.

F. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 16- to 22-kN (3500- to 5000-lbf) compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.

1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 900 mm (36 inches) of uncompacted pavers adjacent to temporary edges.
2. Before ending each day's work, compact installed pavers except for 900 mm (36-inch) width of uncompacted pavers adjacent to temporary edges (laying faces).
3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 90 mm (36 inches) of laying face.
4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with non-staining plastic sheets to protect them from rain.

G. Spread polymeric sand and fill joints as recommended by the manufacturer.

H. Do not allow traffic on installed pavers until sand has been vibrated into joints.

I. Repeat joint-filling process 30 days later or as recommended by the manufacturer.

3.6 MORTAR SETTING-BED APPLICATIONS

A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.

B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Do not exceed 1/16-inch thickness for bond coat. Limit area of bond coat to avoid its drying out before placing setting bed.

C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

D. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.

E. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch thick bond coat to mortar bed or to back of each paver with a flat trowel.

F. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surface or adjusting joints.

G. Polymeric Sand Joints: Spread polymeric sand and fill joints as recommended by the manufacturer.

H. Grouted Joints: Grout paver joints complying with ANSI A108.10.

I. Grout joints as soon as possible after initial set of setting bed.
   1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
   2. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
   3. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
   4. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.
   5. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

3.7 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

   1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
   2. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

END OF SECTION 321400

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.
3. Sustainable Design Intent: Comply with project requirements intended to achieve sustainable credits, as indicated design, measured and documented according to LEED v4 BD+C construction prerequisites and credits, as indicated on the LEED v4 Matrix. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for mandatory and targeted strategies.

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. LEED Submittals:
   1. One LEED Materials Reporting Form with each Product Data submittal, with supporting documentation:
      a. Environmental Product Declaration
      b. Recycled Content
      c. Health Product Declaration and/or Cradle to Cradle Certification
      d. UL Greenguard Gold Certification for paints, coatings, ceiling assemblies, wall assemblies, adhesives and sealants
      e. CRI Green Label Plus Certification for carpets and carpet padding
      f. SCS Floorscore Certification for flooring and subflooring
      g. UF/NAUF Certification for wood products
      h. FSC Chain of Custody certificate and invoices for all FSC wood products

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 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.

2.3 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. For cast-in-place concrete curbing, a 1/2 inch joint shall be filled with joint filler at intervals of approximately 50 feet, and contraction joints shall be placed at intervals of approximately 15feet.
2. **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.

2.4 JOINT FILLER

A. Joint filler shall meet the requirements of Form 818, M.03.08-2.

2.5 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 EDGE FORMS 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 INSTALLATION

A. Ensure all forms are clean and straight or curved to the radii indicated on the drawings.

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. Place maximum 6” layers.
   1) Compact each layer uniformly to 95% Modified AASHTO Laboratory density (ASTM D-1557, Method C).

c. Curb Installation

d. Set on edge. Settle into place with a heavy wooden hand rammer.
   1) Place concrete curbing to the dimensions and shapes as detailed.
   2) Backfill with approved material.

3.5 REPAIRING AND CLEANING

A. Remove and replace curbing sections that are chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new curbing to match adjoining and install in same manner as original units, with same joint treatment and with no evidence of replacement.

a) Cleaning: Remove staining from exposed surfaces of curbing; wash and scrub clean.

END OF SECTION 321613

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SECTION 321727 – ELECTRIC SNOWMELT SYSTEM

See next pages for additional information

Warmup
The world's **best-selling** floor heating brand™

Letter of Transmittal

Customer Information

Company: RZ Design Associates
Address: 750 Old Main St, #202
City, State, Zip: Rocky Hill, CT, 06067
Contact Name: Satish Molleti
Contact Email: smolleti@rzdesignassociates.com
Contact Phone: 860-436-4336

Job Information

Date: 02/01/2023
Job #/Reference: QTUS/72522
Job Name: Bloomfield Library Bridge Snow Melt

We are sending you

- [x] Specification(s)
- [x] Installation Manual(s)
- [x] Layout(s)
- [ ] Sample(s)
- [ ] Other:

These are transmitted as checked

- [ ] For Approval
- [ ] Approved as Submitted
- [ ] For Review and Comment
- [ ] Approved as Noted
- [ ] As Requested
- [ ] Returned for Corrections
- [ ] For Bids Due:

Remarks

Quotation

Warmup Inc
25-A Francis J Clarke Circle
Bethel
Connecticut
CT 06801

T: 888-927-6333 / 888-warmfeet F: 888-927-4721
E: us@warmup.com W: www.warmup.com

Date 2/1/2023
Quotation # QTUS/72522

Currency
Quote Type
Project Bloomfield Library Bridge Snow ...
PO #
Price Level
Total Amps
Total Order Weight (lbs) 239.27

Bill To

RZ Design Associates, Inc.
750 Old Main st
#202
Rocky Hill CT 06067
United States

Ship To

RZ Design Associates, Inc.
750 Old Main st
#202
Rocky Hill CT 06067
United States

Room	Area	Item	Description	Quant...		
Mats	760 heat...	WSMM-240/6000	Snow Melting Mats, 3“ cable spacing, 37.5W per sq ft, 16.4‘ cold lead, twin-conductor heating cable 1/4“TH, 208V, covers 120 sq ft - 2’W x 60’L, 21.7 amps, 4507W	6		
		WSMM-240/2000	Snow Melting Mats, 3” cable spacing, 37.5W per sq ft, 16.4’ cold lead, twin-conductor heating cable 1/4”TH, 208V, covers 40 sq ft - 2’W x 20’L, 7.2 amps, 1502W	1		
Controller		ODC-COMBOX6...	Plug-and-Play outdoor controller with 4 x 50A/3pole contactors allowing for a total load of 600A with a minimum power supply of 150A (3-phase power). 230A Max load at 240V supply. Comes in LED enclosure with GFEP protection, built-in Digital controller and ground temperature sensor. 3-Phase power and any transformers are the responsibility of the Electrical Contractor. AirSense sold separately.	1		
Air Sensor		ODC-AIRSS	Outdoor moisture and temperature sensor	1		
Air Sensor Bracket		ODC-AIRSS-B	Mounting bracket for AirSense Sensor	1		
Required Nameplate		WSM-NMP	Branded Name Plate for use with Warmup Snow Melt Heater installations (NEC426-13)	1		
Tester		DCT-SBOX	The Dual Cable Tester allows for two load-neutral-ground connections of heating cables of any voltages. It will measure resistance from 2 to 1000 Ohms to make sure the integrity of the heating cable has not been compromised.	1		
Zip Ties (for stairs)		SR-ZT-100	Bag of 100 Heavy Duty Zip Ties (100). 7“ long. For use with WSM, WODH and NAMSR cable series. 50lbs load bearing capacity.	1		
Disclaimer --			The customer is responsible for notifying and			

To order, please return signed estimate to 888-927-4721 or contact our order department at us@warmup.com. Estimates are valid for 30 days. This estimate is based on information provided by the client and must be field verified prior to purchase. The client is solely responsible for ensuring that all information provided to Warmup is accurate. Applicable sales taxes may be added at time of purchase. Additional freight may apply. Warmup Inc supplies specified materials only. Installation not included.

Installation must be in accordance with the Warmup Installation Manual as well as applicable code regulations. Warmup guarantees its products against factory defects and workmanship. Please check product specifications for applicable warrantees. Call 888-927-6333 with any questions regarding your estimate.

Quotation

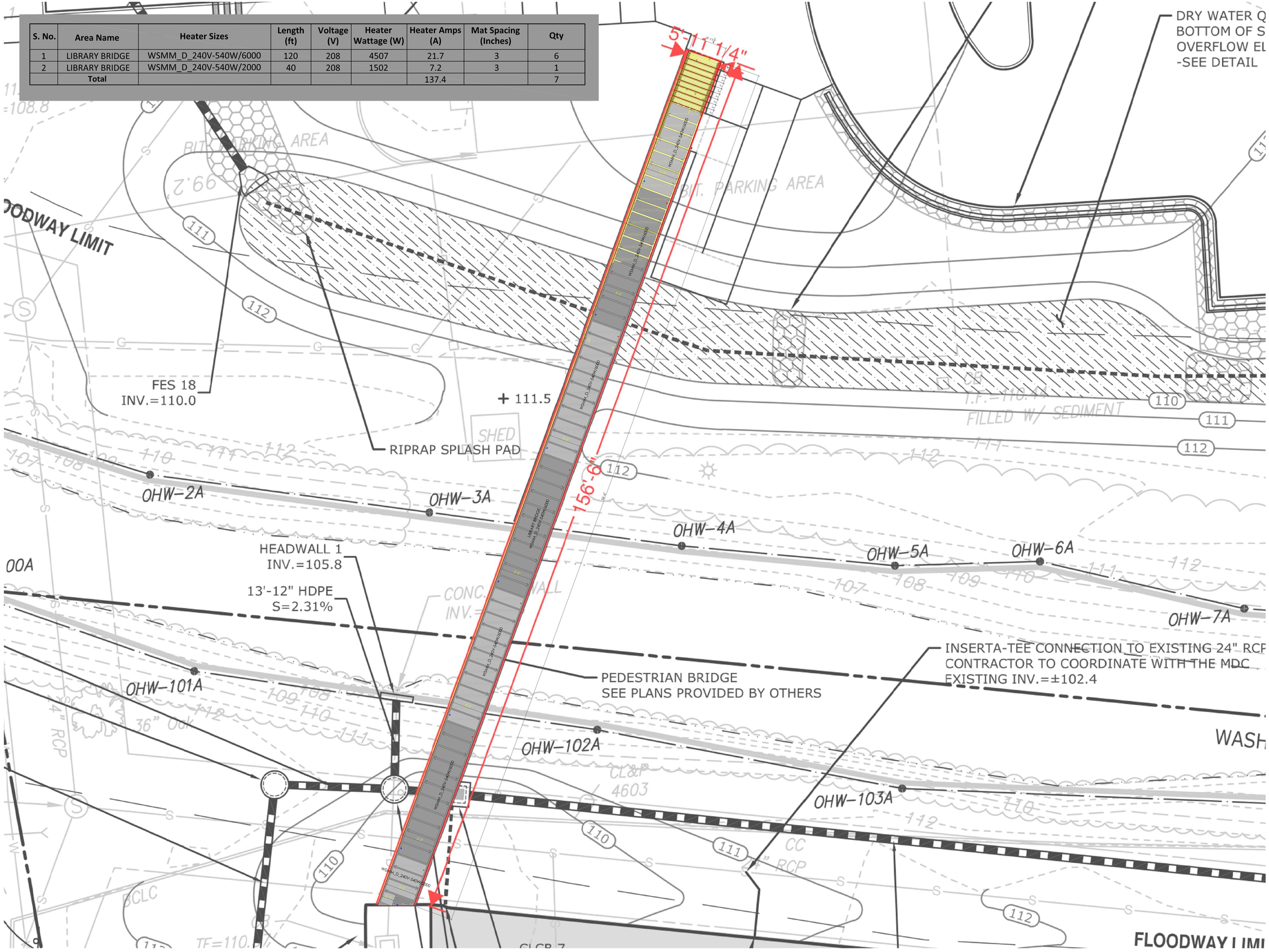
Date 2/1/2023
Quotation # QTUS/72522

Room	Area	Item	Description	Quant...	Rate	Amount
Snow Melt			providing Warmup with exact locations of any expansion or control joints (if applicable) before purchasing. Crossing expansion or control joints with the heating cable should be avoided, however, if this is not possible contact your Warmup quoting specialist for installation recommendations and requirements.			

To order, please return signed estimate to 888-927-4721 or contact our order department at us@warmup.com. Estimates are valid for 30 days. This estimate is based on information provided by the client and must be field verified prior to purchase. The client is solely responsible for ensuring that all information provided to Warmup is accurate. Applicable sales taxes may be added at time of purchase. Additional freight may apply. Warmup Inc supplies specified materials only. Installation not included.

Installation must be in accordance with the Warmup Installation Manual as well as applicable code regulations. Warmup guarantees its products against factory defects and workmanship. Please check product specifications for applicable warrantees. Call 888-927-6333 with any questions regarding your estimate.

S. No.	Area Name	Heater Sizes	Length (ft)	Voltage (V)	Heater Wattage (W)	Heater Amps (A)	Mat Spacing (Inches)	Qty
1	LIBRARY BRIDGE	WSMM_D_240V-540W/6000	120	208	4507	21.7	3	6
2	LIBRARY BRIDGE	WSMM_D_240V-540W/2000	40	208	1502	7.2	3	1
Total						137.4		7



Copyright: The copyright in this drawing belongs exclusively to Warmup plc and its use is governed by the terms and conditions of contract between Warmup and its client. This drawing may only be used by the client for the project at the location specified. It may not be copied, reproduced in any way in whole or in part or disclosed to any other third party.

Disclaimers: ***The purpose of this drawing is for guidance only, field adjustments may be necessary***. This drawing must be read in conjunction with all other relevant drawings and Warmup product specifications and operating manuals. The Product drawings shown are not to be used for construction purposes. Full details of product dimensions and installation requirements are contained within Warmup's product manuals. The drawings are based on information and data supplied by the client. The client is solely responsible for ensuring that site-specific changes and dimensions are brought to Warmup's attention. Any use made of this drawing by any third party is entirely at the risk of such third parties. No responsibility will be accepted for any alteration and/or deviation from this design. All work on site to be carried out to the entire satisfaction of the local authority building control department and any other relevant statutory body notwithstanding anything shown or indicated on this drawing.

The customer is responsible for notifying and providing warmup with exact locations of any expansion or control joints (if applicable) before purchasing. Crossing expansion or control joints with the heating cable should be avoided, however, if this is not possible contact your warmup quoting specialist for installation recommendations and requirements.

Design Layout Legend

- start of lead connection
- T — suggested Control Location
- R — Relay
- loose laid cable (heating elements that has been removed from mattling)
- directional arrows

WARMUP Notes & Materials

Warmup®

The world's **best-selling** floor heating brand™

Tel (888)927-6333
www.warmup.com

PROJECT:	BLOOMFIELD LIBRARY BRIDGE SNOW MELT L-WSMM-208
TITLE:	
SCALE: 1/8"=1'-0"_ D	DATE: 01.02.2023
DESIGNER: AT	NUM: 01
PROJECT MANAGER:	

Warmup

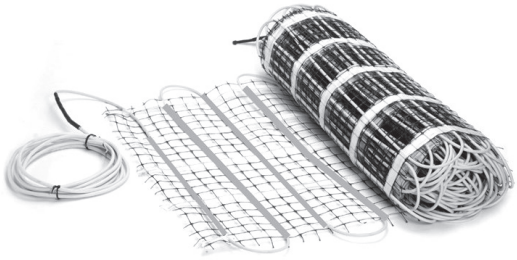
The world's **best-selling** electric floor heating brand™

WSMM Snow Melting Mats

SPECIFICATION SHEET WSC-0729

PRODUCT CODES

WSMM-240/6000 // WSMM-Voltage/Wattage



PRODUCT DESCRIPTION

The WSMM (Warmup Snow Melting Mat) is commonly used in concrete pours, asphalt driveways and paved walkways. All Warmup Mats are rated for 208-240 applications. Mats are 2ft or 3ft wide and with a cable spacing providing 50w/sqft for optimum results under even the harshest conditions. Embedded up to 4" deep, they can be laid out as tire-tracks or for full coverage designs.

ADVANTAGES

- 16ft cold lead, single point connection
- Easy roll-out installation
- In sand, gravel or on wire mesh

LIMITATIONS

- Do not cut the cable or apply the cable with staples. Apply caution to avoid nailing through the cable and avoid installation under permanent fixtures.

SPECIFICATIONS

Operating voltage	240V & 480V
Output rating	± 50 W/sq ft
Mat width	2ft or 3ft wide
Lengths	Range from 5' (152cm) up to 60' (1828.8cm)
Construction	Energy efficient twin-conductor heating cable of 1/4" (6mm)
Maximum temperature threshold	464˚F (240˚C)
Cold tail length	16.4' (610cm)

C SP US

Warmup 10-Year Limited Warranty

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WSMM Snow Melting Mats

SPECIFICATION SHEET WSC-0729

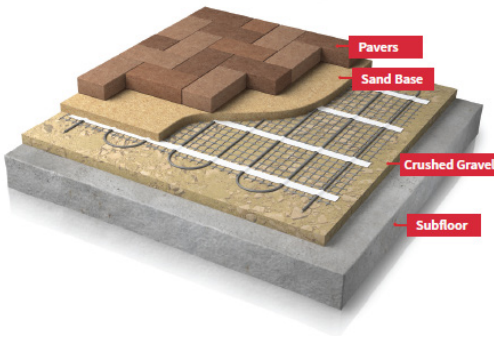
TECHNICAL DATA

Applications

Suitable Coverings	Pavers and related masonry
	Asphalt (direct contact or indirect contact)
	Concrete (not lightweight)
Suitable Base	Crushed gravel base
	Sand bed
	Insulation sheets
Min. coverage	2″
Max. coverage	4″

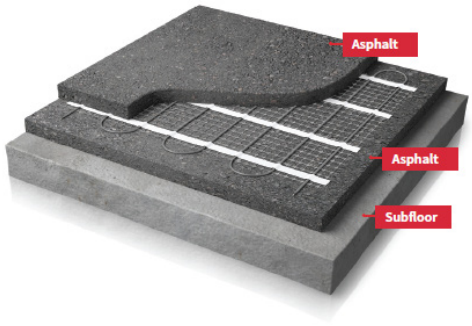
Installation under PAVERS

Mats should be covered with 2″ of sand for paver application. Pavers to be maximum 4″ thick.



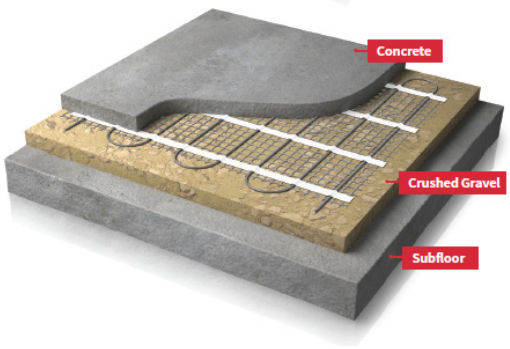
Installation under ASPHALT

Cable will withstand direct asphalt contact for limited time until asphalt cools. For pours hotter than 220F, apply a layer of 2″ of sand over the cable prior to laying asphalt. Do not use rollers over 2 Ton. Hand-rolling highly recommended.



Installation under CONCRETE

Ensure the pour is 4″ maximum over the cable. Use re-mesh or wire mesh to secure the cable in the middle of the pour for deeper pours. Cable/Mats can be zip tied to mesh and mesh can be raised with bricks or pulled during pour.



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WSMM Snow Melting Mats

SPECIFICATION SHEET WSC-0729

PRODUCT SIZE LISTING

Voltage	Area (sqft)	Code (2ft wide)	Mat Length (ft)	Wattage	Amps	Resistance (Ω)
240V	10	WSMM-240/500	5	500	2.1	115.20
	20	WSMM-240/1000	10	1000	4.2	57.60
	30	WSMM-240/1500	15	1500	6.3	38.40
	40	WSMM-240/2000	20	2000	8.3	28.80
	50	WSMM-240/2500	25	2500	10.4	23.00
	60	WSMM-240/3000	30	3000	12.5	19.20
	70	WSMM-240/3500	35	3500	14.6	16.46
	80	WSMM-240/4000	40	4000	16.7	14.40
	90	WSMM-240/4500	45	4500	18.8	12.80
	100	WSMM-240/5000	50	5000	20.8	11.50
	120	WSMM-240/6000	60	6000	25.0	9.60

Voltage	Area (sqft)	Code (3ft wide)	Mat Length (ft)	Wattage	Amps	Resistance (Ω)
240V	30	WSMM-240/3x10	10	1500	6.3	19.20
	60	WSMM-240/3x20	20	3000	12.5	16.46
	75	WSMM-240/3x25	25	3750	15.6	15.38
	90	WSMM-240/3x30	30	4500	18.8	14.40
	120	WSMM-240/3x40	40	6000	25.0	12.80

Voltage	Area (sqft)	Code (2ft wide)	Mat Length (ft)	Wattage	Amps	Resistance (Ω)
480V	30	WSMM-480/1500	15	1500	3.12	153.84
	40	WSMM-480/2000	20	2000	4.16	115.38
	60	WSMM-480/3000	30	3000	6.25	76.8
	80	WSMM-480/4000	40	4000	8.33	57.62
	120	WSMM-480/6000	60	6000	12.50	38.40

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WSMM Snow Melting Mats

SPECIFICATION SHEET WSC-0729

WARRANTY & MAINTENANCE

When installed according to the installation manual and proper testing has been performed throughout, the system requires no maintenance for the duration of its warrantied life.

The WSMM cable is warrantied for 10 years against manufacturer's defects and is protected by Warmup's SAFETYnet guarantee. See www.warmup.com for full warranty details.

TECHNICAL SUPPORT

Warmup is available 24/7/365 at (888) 927-6333.

For quotes, layouts and specific technical information, contact us at:

Warmup USA
1+ (888) 927-6333
ussales@warmup.com

Warmup CANADA
1+ (888) 927-6333
ca@warmup.com

RELATED PRODUCTS

- WSM-252W - see WSC-0115
- Commbox-600 - see WSC-0927
- DS series controls - see WSC-0809

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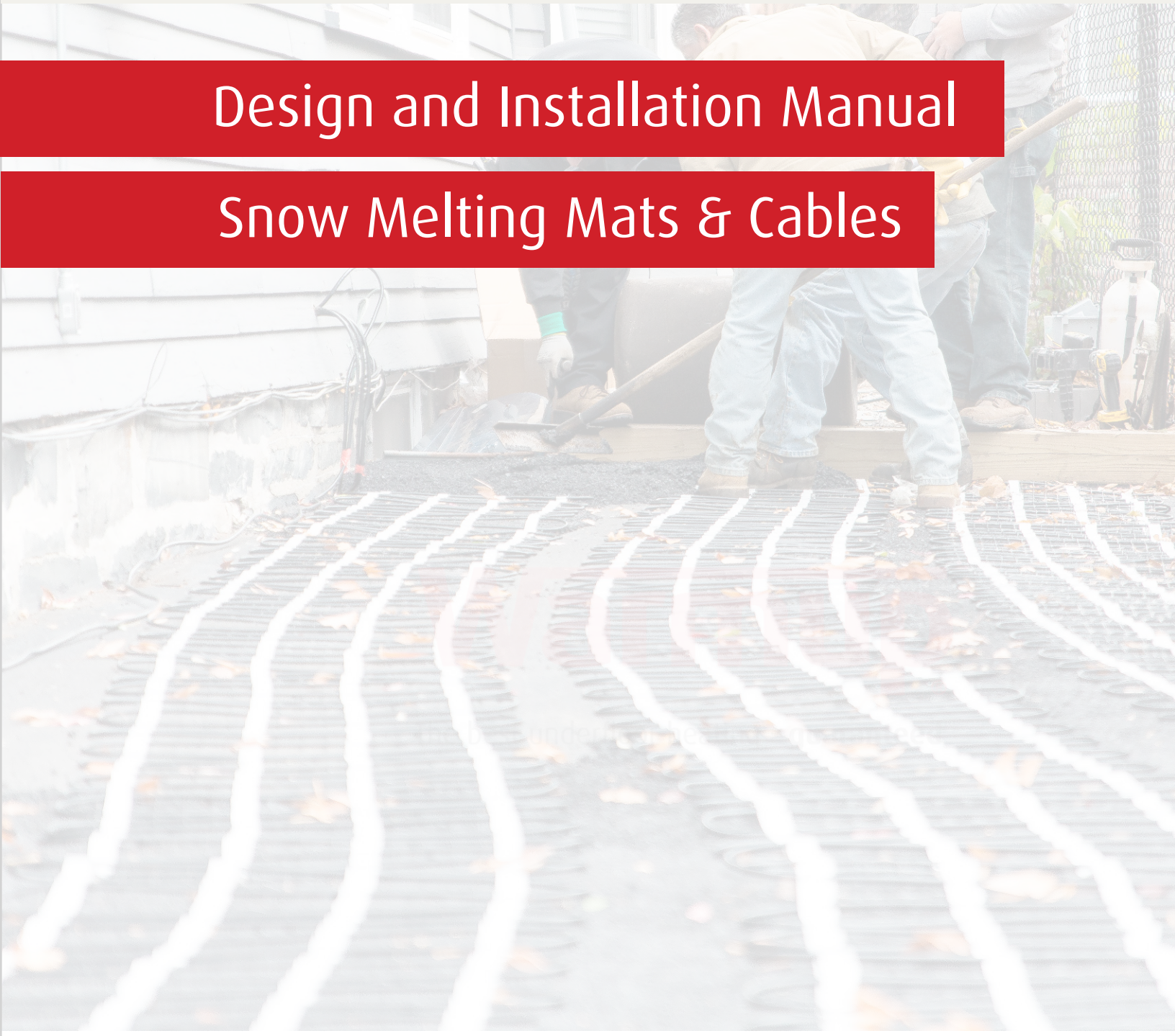
Design and Installation Manual

Snow Melting Mats & Cables



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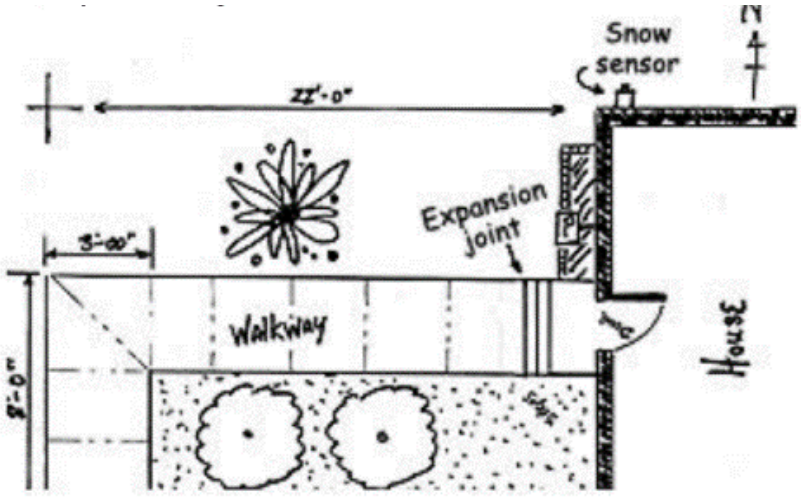
Planning your Installation

Before any product decisions are made, the first step is to draw a plan of the area. Snow melt products can be installed in walkways, driveways and on steps. Commercially, it extends to ramps, docks, access areas and parking lots. Whether you have blueprints or a quick sketch, ensure you have received a detailed layout and panel schedule from Warmup in order to reference during and after installation.

Mark dimensions, electrical access points, any steps and expansion joints.



Sample layout drawing.

Product Selection

The first choice is between mats and cables. Mats are typically better suited for larger straight areas or for patterns like tire-tracks. Cables are a better fit for curved areas, custom patterns and steps. You may need to combine both in your design.

The default voltage is 240V. Residentially, that is the most common choice, but commercially, 3-phase supply or even 480 volts may be available. The higher the voltage, the lower the amperage and the larger the area that can be fit on one controller.

Efficiency of the system is the same regardless of voltage. Only wattage affects cost of operation and the system output is the same between mats and cables of any voltage.

Do note however that cables are typically recommended at 4" spacing on re-mesh while mats are pre-spaced at 3". So the output of mats would be higher unless cables are spaced at 3".
When powering a system at 208V, the mats and cables would be "de-rated" from 240V down to 208V. This means that a WSMM mat with a 50w/sqft output would now have a 42w/sqft output (=50/240*208). Do not design a system at less than 35w/sqft.

Controlling your System

Warmup strongly advises to use one of its selection of automatic controllers. While a system can technically operate from a breaker or timer, automatic controllers allow for cost-effective operation. From our testing, activating a system before snow fall makes it at least twice as effective at preventing accumulation.

WIFI systems that anticipate snow will allow you to design a system at lower wattage density (i.e. lower cost of operation) as it will have more time to "pre-heat" before it snows.

Important Considerations

Measure and plan the area to be heated with the snow melt mats/cables, allowing for obstructions such as lights, poles, columns, handrails or drains.

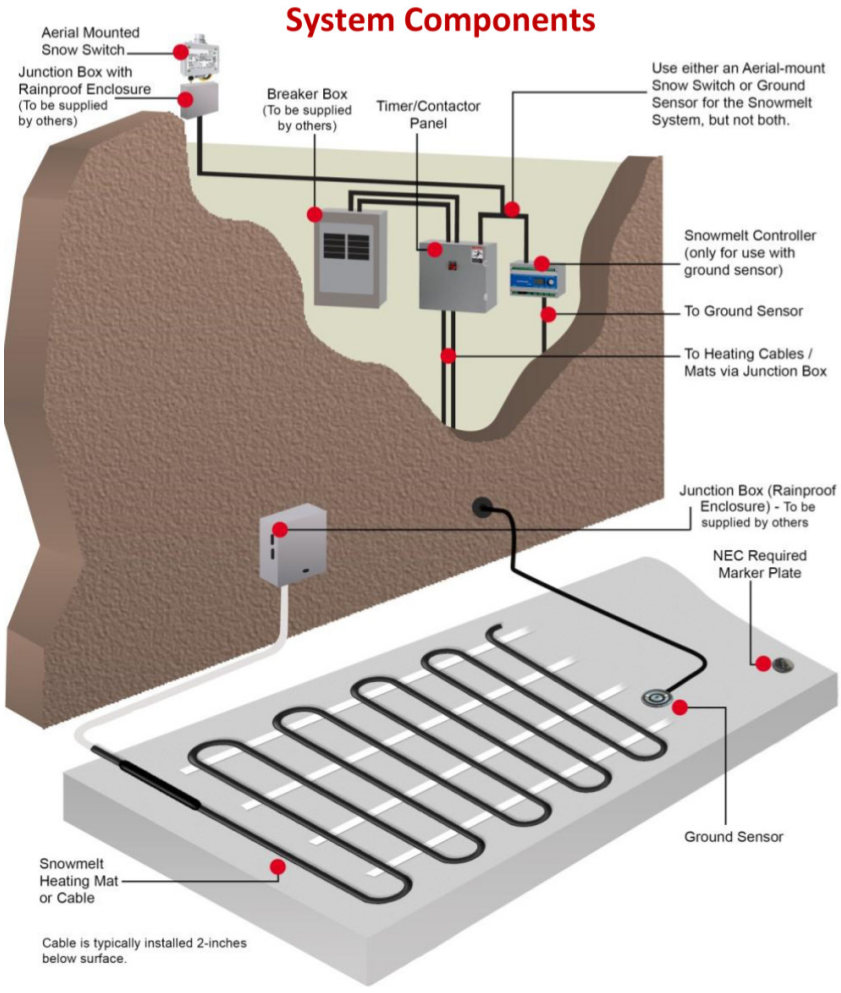
1. The heating cable should not cross or overlap itself at any point. This could cause the cable to overheat, requiring replacement.
2. The heating cable should not be cut, shortened or lengthened.
3. Take precautions to avoid damage to the heating cable during installation. Do NOT drop sharp objects or drive directly on the cable. Take care when pouring concrete or asphalt onto the cable.
4. Installation of the snow melt mats and cables should not be undertaken if ambient temperature is below 32F/0C.
5. Minimum bending radius of the heating cable while laying shall not be less than approximately 3 inches (75mm).
6. The cold lead, normally 16'4" long (5m), can be cut/extended to suit the location of the electrical power connection box.
7. Snow/Moisture detection sensor location shall be in the open area, away from trees or bushes, so that it can sense moisture in the air/snowfall and initiate the energization of the heating cable.
8. Check the voltage and wattage of the heating cable to ensure you have the right products for your installation. Details are marked on the product box. A qualified electrician should connect the heating system.
9. Check the continuity and resistance of the snow melting mat before and after installing. Resistance value should match the value shown in the Sizing Guide in this manual (pages 6 and 7) or your product Specifications Sheet (WSC0726 abd WSC0729). A tolerance of 5% to 10% is allowed.
10. Testing the system with a Megger (ACC-MEGG) for insulation resistance is highly recommended.
11. Keep high voltage power wires in a separate conduit from the low voltage wire.
12. Snow Melting Mats/Cable should be connected to a GFEP protected breaker in the panel. Consult a qualified electrician for local code requirements. Some controllers have built-in GFEP protection and can accept standard breakers.
13. Allow sufficient drying or curing period of the concrete/asphalt/sand after installing the snow melting mat / cable and before energizing the heating cable.
14. Always keep a copy of the cable or mat layout for future reference. Ideally, snap some pictures of the installation before pour and store with other product documentation.
15. All outdoor embedded installations must include the application of a nameplate provided by the manufacturer under NEC 426-13.

NOTE: The installation shall be in accordance with all enclosed instructions and in compliance with local and national electrical codes, namely part 426 of ANSI/NFPA, the NEC and CEC (Canadian Electrical Code), part 1 (re: GFCI, GFEP and RDC's).

NEVER power up the heating cable prior to being buried in concrete, asphalt or in sand (even for testing purposes).

ALL ELECTRICAL WORK MUST BE COMPLETED BY A LICENSED AND QUALIFIED ELECTRICIAN AND IN ACCORDANCE WITH LOCAL LAWS, CODES, REGULATIONS AND NEC GUIDELINES.

System Components



Designing Your System: Choosing Mats, Cables and Output

The Heating Cable on the Snow Melting systems consists of a resistance-heating element insulated with Fluoropolymer. A metallic sheath is provided to give additional mechanical strength and a ground path. A final outer jacket of Zero Halogen Polyolefin based compound is given to make it sturdier and provide corrosion protection.

Product Specifications

Snow Melting Mats/Cables are uniquely designed for snow melting in parking lots, driveways, pavements, stairs, bridges, roofs, etc. with total safety. Snow melting systems are heating cables taped to a sturdy mesh for fast, easy installation.

Snow Melting Mats consist of a twin conductor heating cable taped onto the Polypropylene mat. The heating cable is laid in a winding fashion so that they are equally spaced (3" apart) and evenly distributed on the mat.

Type	Twin Conductor
Voltage Rating	240V, 480V or 600V
Output	50W/sq ft (540W/sq m) at 3"
Lead	16' 4"
Bending Radius	Minimum 1-1/2"
Cable Diameter	1/4"
Wire Insulation	Fluoropolymer
Casing	Zero Halogen Polyolefin
Max Temperature	454 F / 240 C
Min Installation Temp	14 F / -10 C

WSMM Mats

Voltage	Area (sqft)	Code	Mat Length (ft)	Wattage	Amps	Resistance (Ω)
240V*	10	WSMM-240/500	5	500	2.1	115.20
	20	WSMM-240/1000	10	1000	4.2	57.60
	30	WSMM-240/1500	15	1500	6.3	38.40
	40	WSMM-240/2000	20	2000	8.33	28.80
	50	WSMM-240/2500	25	2500	10.43	23.00
	60	WSMM-240/3000	30	3000	12.5	19.20
	70	WSMM-240/3500	35	3500	14.6	16.46
	80	WSMM-240/4000	40	4000	16.7	14.40
	90	WSMM-240/4500	45	4500	18.8	12.80
	100	WSMM-240/5000	50	5000	20.86	11.50
	120	WSMM-240/6000	60	6000	25.0	9.60

Voltage	Area (sqft)	Code	Mat Length (ft)	Wattage	Amps	Resistance (Ω)
240V*	30	WSMM-240/3x10	10	1500	6.3	38.4
	60	WSMM-240/3x20	20	3000	12.5	19.2
	75	WSMM-240/3x25	25	3750	15.6	15.6
	90	WSMM-240/3x30	30	4500	18.8	12.8
	120	WSMM-240/3x40	40	6000	25.0	9.6

*all mats can be connected to 208V and 240V, single phase and 3 phase power. Please check our Technical Data Sheets for variations to Wattage output and Amperage Load under different Voltages.

Voltage	Area (sqft)	Code	Mat Length (ft)	Wattage	Amps	Resistance (Ω)
480V	30	WSMM-480/1500	15	1500	3.12	153.84
	40	WSMM-480/2000	20	2000	4.16	115.38
	60	WSMM-480/3000	30	3000	6.25	76.8
	80	WSMM-480/4000	40	4000	8.33	57.62
	120	WSMM-480/6000	60	6000	12.50	38.40

WSMM Cables

Voltage	Length (ft)	Code	3″	4″	5″	Wattage	Amps	Resistance (Ω)
240V*	84	WSM-240/1000	20	27	34	1000	4.2	57.1
	168	WSM-240/2000	43	57	72	2000	8.3	28.9
	209	WSM-240/2500	51	67	84	2500	10.4	23.1
	251	WSM-240/3000	62	84	104	3000	12.5	19.2
	330	WSM-240/4000	85	110	135	4000	16.90	14.2
	420	WSM-240/5000	100	140	170	5000	20.86	11.5
	500	WSM-240/6000	122	181	200	6000	25.0	9.6

*all mats can be connected to 208V and 240V, single phase and 3 phase power. Please check our Technical Data Sheets for variations to Wattage output and Amperage Load under different Voltages.

Voltage	Length (ft)	Code	Wattage	Amps	Resistance (Ω)
480V	84	WSM-480/1000	1000	2.08	230.77
	209	WSM-480/2500	2500	5.20	92.30
	342	WSM-480/4000	4000	8.33	57.62
	500	WSM-480/6000	6000	12.50	38.4

Voltage	Length (ft)	Code	Wattage	Amps	Resistance (Ω)
600V	84	WSM-600/1000	1000	1.7	360
	209	WSM-600/2500	2500	4.2	144
	342	WSM-600/4000	4000	6.7	90
	500	WSM-600/6000	6000	10	60

While a 240 Volt system is the default choice, sites with alternative power supply can consider alternatives. See our heat output and spacing guide below.

Spacing and Heat Output

When using the pre-assembled Warmup Snow Melting mats, the standard cable spacing is approximately 3" and provides 50 watts of output per square foot.

While 50w/sqft is common in the industry, it is more than the necessary output for most installations. Outside of installations in northern Canada or in ski resorts experiencing high levels of accumulation, 40w/sqft is plenty to melt snow.

It has been demonstrated through testing that it is not necessarily the output that drives melting, it is the ability for the system to activate and heat up BEFORE the snow fall in order to prevent accumulation, rather than fight it.

This is why Warmup recommends its WSM-63 Timer panel, WSM-252W with WIFI option and automatic sensor controllers.

Spacing and Heat Output

	Power	208V	240V	277V
Standard 240V Mats & Cables				
WSMM Mats	3" Spacing	43	50	58
WSM Cables	3" Spacing	43	50	58
	4" Spacing	33	38	44
	5" Spacing	26	30	35

Cable De-Rating

It is possible and allowed to "de-rate" the power of a cable. In order to maintain the mats spaced as provided (3" spacing with 50w/sqft output), you can supply the 240V-rated mats with 208V power.

De-rating the mats from 240V to 208V will bring a 50w output down to about 40w/sqft. This technique is used to obtain more coverage with less amperage load.

De-rating can work in the opposite direction, with installations at 277V (480V/3phase) where the output climbs to 57w/sqft. In this instance Warmup only allows the use of loose cable and spacing at 4 or even 5" apart to bring the output back between 40 and 50w/sqft.

Refer to the WSM and WSMM technical spec sheets for an exact wattage output and amperage draw based on voltage variations. When in doubt, contact a Warmup representative at 888-927-6333 US or 888-592-7687 CAN.

Spacing and Heat Output

System / Power	208V	240V	277V	347V	480V	600V
240 volts	0.86	1	1.15	N/A	N/A	N/A
480 volts	N/A	N/A	N/A	0.72	1	N/A
600 volts	N/A	N/A	N/A	N/A	0.8	1

3-Phase Wiring

In the instance when the power supply is available in 3-phases, check with an electrician to determine the best design for your system. It is important to note that the efficiency and cost-effectiveness of the system is NOT impacted by voltage. Electrical bills are paid in WATTS (KiloWatts) and the resulting output/wattage of a system is usually identical regardless of VOLTAGE. This is not always true in the case of de-rating, so check the section above for resulting output.

The main benefit of higher voltages or 3-phase wiring is the reduction in Amperage draw. The equivalent mat or cable at 480V will draw half the amperage than the 240V size. This mainly affects the ability to connect more cables and more square footage on a given amount of amperage. It also utilizes less room on the electrical panel.

There are 3 common 3-phase configurations: 208, 277 and 480V.

Please contact Warmup for 3-phase wiring compatibility and control panel selection.

Controlling your Snow Melting System

Your Warmup Snow Melting system should be controlled by the approved and supported Warmup control devices. Choosing the right controller is a matter of usage and required specifications by the contractor or engineer. What to look for in a controller?

• Do you want simple operation for a smaller residential system? **Check out the section on ODC-ASE-DS2C/5C controllers.**

• Are you looking for a larger installation or WIFI Connectivity? **Check out our WSM-63 Timer panel and the WSM-252W Wifi controller.**

• Do you need integrated sensors, in-ground or on roof? **Consider the ETO2.**

• Do you need all the above and GFEP protection? **Check out the ODC-Resibox and COMMBOX-600 panels.**

In many instances, a simple ASE-DS5 outdoor-mounted controller will suffice to automatically activate the system during snow fall. Your selection above will also be determined by the amount of amperage you need to switch.

	Amperage	Voltage
ODC-ASE-DS2C	30	100-240
ODC-ASE-DS5C	2 X 30	100-240
ODC-RESIBOX	4 X 30	100-600
COMMBOX-600	4 X 50	100-600
WSM-63	4 X 63	100-600
WSM-252W	4 X 63	100-600

Connecting to ODC-ASE-DS2C or ODC-ASE-DS5C

Several controllers are “all-in-one” and include the sensor. This is the case for the ASE-DS2 or 5 where the sensor is built-in. Even the load switching is built-in, so you only need the heaters and the controller. The DS-2 switches up to 30 amps and the DS-5 up to 2 x 30 amps.

Connecting to WSM-63 and WSM-252W

But these systems are limited in their functionality and total amperage capacity. For that reason, in larger installation, a WSM-63 or WSM-252W will be recommended. These systems can be activated by a ASE-DS2 sensor, or operate manually as a Timer Panel (WSM-63). The WSM-252W is WIFI enabled and is triggered by the weather forecast data captured on the WSM app for Android and iOS.

Connecting to ET02

Multi-zone systems are available as well, though Warmup cautions about excessive zoning. Once the snow builds up in an area, it is very difficult for any system to catch up and melt it. The ET02 system allows for dual zone operation. It requires a contactor panel (WSM-63 or as provided by installer) as well as external sensors.

ET0G sensors are placed in-ground and ET0R sensors are placed on roof or in gutters.

Connecting to ODC-RESIBOX or COMMBOX-600

The Warmup Resibox-120 and Commbox-600 provide multi-zone operation and have built-in GFEP protection. The Resibox can switch 4x30A and the Commbox switches up to 4 x 50A. The latter can also be used up to 600V and with 3-phase power supply.

These controllers will require a wall-mounted sensor (AIR-SENSE) to activate.

Scan for More Technical Information

Mounting Your Controller

Refer to the installation instructions specific to each controller. Depending on specifications, some are mounted indoors and some outdoors. “All-in-one” controllers also require caution so that they are mounted in an exposed area where they can capture falling snow.

Outside of these, it is always recommended to mount controllers indoors to ensure the proper functioning and long-life of the electronic components.

Be mindful of public access to controllers and prevent unauthorized access to the devices.

Selecting a Sensor

There are three types of sensor available in the Warmup range

1. Built-in
2. In-ground
3. Aerial mounted

The built-in sensors are limited to the ASE-DS2 and 5 devices. These are simple but easy to use and easy to install devices for installations under 300 sqft. Because the sensors are built-in, they do not require any rough-in prep.

In-ground sensors like the SIT-6E or the ETOG are used when slab sensing is recommended due to drifting snow or when creating multiple zones.

The recommended choice is Aerial Sensors, like the Warmup AIR-SENSE. The latter is compatible with the RESIBOX-120 and the COMMBOX-600. Aerial mounted sensors are very accurate and do not get damaged by traffic and debris over time.

No-Sensor Operation

It is technically possible to operate a system without a sensor at all. Timer panels can be very effective for people with installations that can easily be trigger manually. The WSM-63 panel has a variable timer built-in where the user can set it (for example) at 8 hours and activate it a few hours ahead of a scheduled precipitation.

The advanced version of that is the WSM-252W panel where the system will regularly check the local weather forecasts and automatically activate the system based on the snow fall probability. An app for smart devices is available to control, activate and shut-down the system remotely.

Placement of Sensors

While a single sensor suffices for successful operation, some designs locate one sensor where the snow and ice will manifest first, and another where the snow is going to disappear last. This will guarantee complete clearing of snow and ice. For example, on a sloped down driveway to an underground garage, place a sensor at the top and at the bottom of the driveway. Remember a combination of sensors can be ground-ground or ground-roof.

When using only one sensor, you will have to choose between fast detection or the lasting melting period (place it where the snow will disappear last). A single-sensor set-up is by far the most common, and controllers have "Over-run" or "Delay" cycles that allow them to continue to operate for a limited time AFTER snow and ice has been cleared. This is in order to ensure no melted snow re-freezes in place or to handle snow drifts.

Electrical Rough-in and Site Prep

Conduits

Sensors:

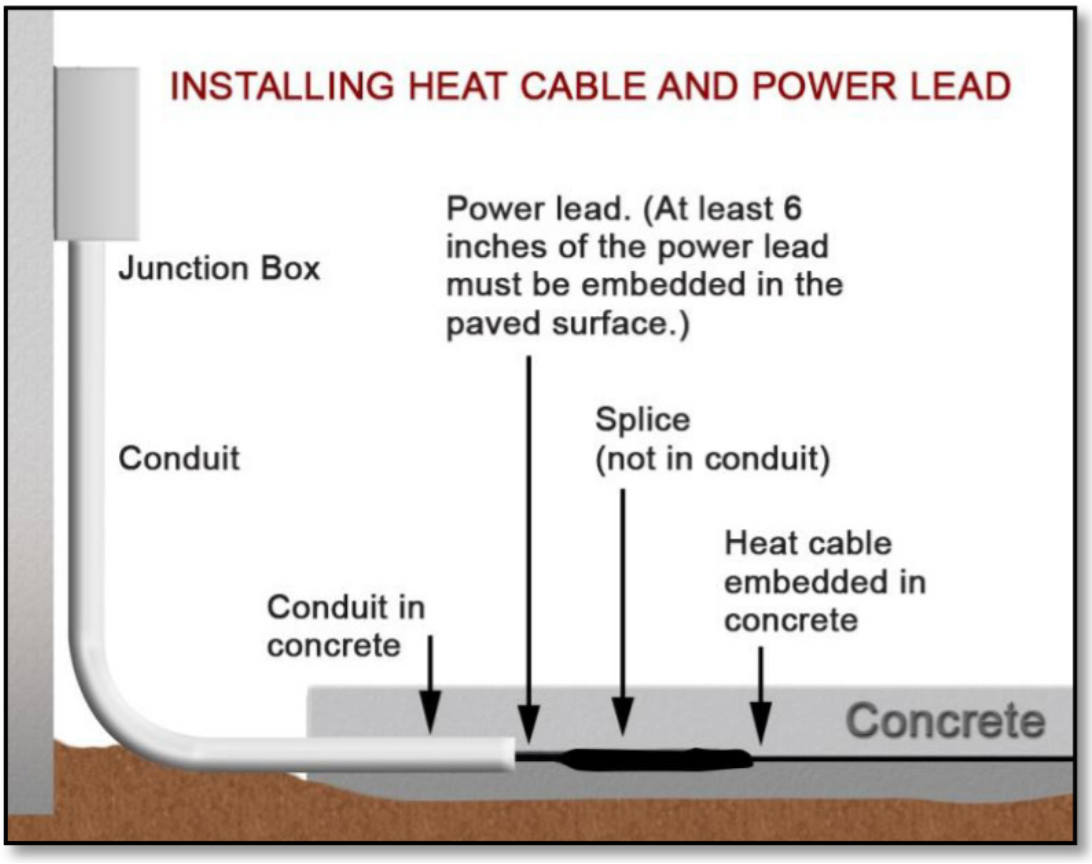
After choosing the location of the sensors, you must install PVC or METAL (based on local code) in order to wire the sensor from its outside location to the control panel. Refer to specific instructions for:

CIT-1
SIT6-E
GIT-1
ETOG
ETOR
AIR-SENSE

Always ensure the conduits are secured to the base (rebar, drained gravel base, blocks) so that they do not move during the pour.

Heating Cables:

Heating cables have 16ft leads and can in many cases directly reach the relay or control panel. In instances where that is not possible, the installer must plan for junction boxes to gather the leads and "home-run" the loads to the relay or control panel.



Electrical Supply

All electrical connections should be performed by a licensed electrician and be in compliance with the appropriate local and national codes.

Based on the amount of mats or cables purchased from Warmup, provide enough amperage supply to the relay contactors. Electrical code typically requires 120% capacity on breakers. So when supplying a 16 amps load (cables/mats) a 20 amp breaker should be supplied.

Make sure to supply the appropriate power to the controller or relay panels in order to operate the mats and cables. Make sure you understand the proper wiring if a 3-phase connection is necessary or recommended by your general contractor as your amperage load requirements will change.

Note that the sensor wires can often be low voltage wires and should therefore ALWAYS be placed in their own, separate conduits. By the same token, while you may place multiple heating cable LEADS inside a single conduit, you should NEVER run the heating portion of the cable inside a PVC or METAL conduit.

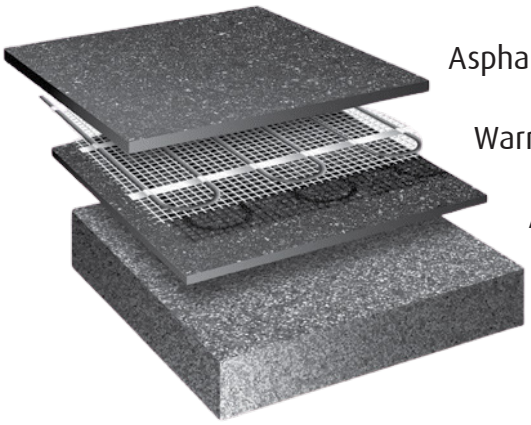
All lead wires may be lengthened or shortened as necessary, but NEVER cut the HEATING CABLE. When extending the lead wires, we recommend the use of a wall-mounted or in-ground weather-proof junction box.

GFCI/GFEP Protection

All circuits provided may require to be GFEP protected, however, some panels have a built-in GFEP protection. Check with your Warmup representative or refer to the specification sheet of the controllers purchased.

You can use a GFEP protection on the breaker or obtain a GF-1 or GF-2 from Warmup which serve as in-line GFEP protections. They respectively protect up to 63A ‘carry’ or 2 x 63A at 30mA trip levels.

Installation Instructions - Under Asphalt



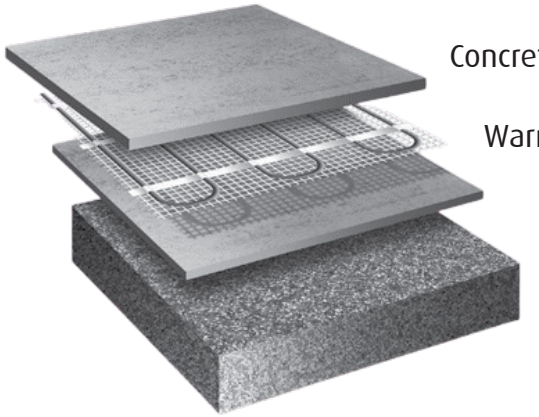
When using the snow melt mats/cables under asphalt, consider embedding them in sand or concrete first.

Note: Using a megohmmeter and multi-meter, an electrician should measure the cable resistance and insulation resistance: (1) before commencing installation, (2) before applying asphalt and (3) after the asphalt is applied. Record the readings in this manual. If there is damage STOP and call Warmup.

1. Ensure the contractor has a firm base of 4"-8" drained base tamped down and ready to receive the asphalt.
2. Warmup highly recommends laying 1" of sand over the base to encase the cables or mats. It is important to keep heavy equipment, machinery, vehicles, shovels and rakes away from the cable to prevent damage during exposure.
3. Unroll the mat or place the cable on the sand layer according to your layout plan and apply another layer of sand before a coat of bituminous binder.
4. As needed, secured the mats or cables with landscape staples or by zip-tying the cable onto a re-mesh wire grid.
5. Once the mats/cables are in place, route the cold lead(s) provided through a rigid metal conduit to return to an accessible weatherproof junction box(es). The electrician may supply "in-ground" junction boxes which can be accessed from above so the rest of the box is buried to avoid damage by vehicles. [Note: ensure none of the heated section of the cable enters the conduit(s)]. Seal the ends of the conduit.
6. Sensors can be placed within the asphalted area. Refer to earlier sections under Placement of Sensors.
7. When the mat/cable is embedded in sand or mortar, the asphalt should not exceed a thickness of more than 2" for optimal results. When pouring asphalt DIRECTLY on the mat/cable, let it cool to 230F or below. Use a maximum of 2" of asphalt for optimal results.
8. After the asphalt hardens, test and record results to verify that there is no damage and to ensure it is ready for activation once the asphalt has cured.
9. Warmup highly recommends hand-rolling the asphalt. However, provided the cables are embedded in sand, a small 1-ton roller can be used.
10. For easy reference, attach a label at the power distribution board, indicating the location of the heating cables.

Maximum roller weight is 1 ton.

Installation Instructions - Under Concrete



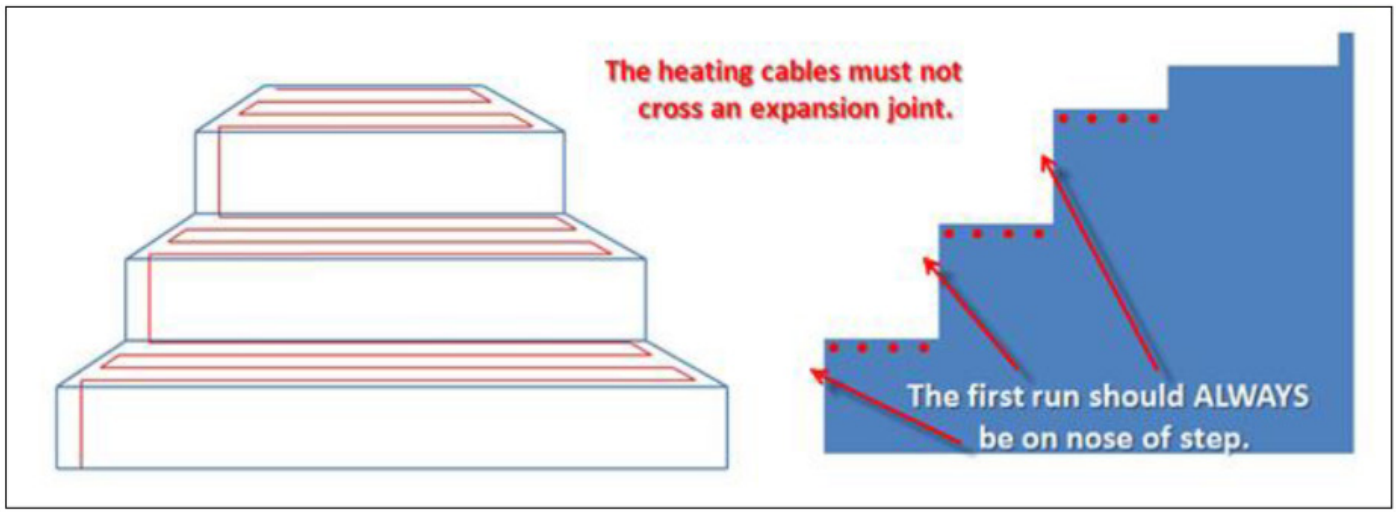
Note: Using a multi-meter, an electrician should measure the cable resistance and insulation resistance: (1) before commencing installation, (2) before pouring concrete and (3) after the concrete is poured. Record the readings. If there is damage STOP and ring 1-888-927-6333.

1.Ensure the paving contractor has a solid base of 4"-8" (102-203mm) of crushed rock aggregate tamped down and ready to receive the pour.
2.Clean the area below the heating mat/cable so that it is free from sharp objects. It is important to keep heavy equipment, machinery, vehicles, shovels and rake edges away from the cable to prevent damage.
3.For locations that require handrails, it is strongly recommended that the concrete installer pre- sleeves the posts to avoid any and all drilling of the concrete. The mat/cable must be routed around these sleeves/ posts to avoid any direct contact with them. See "How To Modify the Mat" if you need to alter the mats.
4.Identify the location of Expansion Joints with spray paint. Avoid crossing over expansion joints and design your system such that each section is covered by separate heating mats. This does not apply to "stress-cuts" in the concrete.
As an alternative, mark the location of the expansion joints on the sub-base with chalk or spray-paint and use the following technique: Apply a 2" x 2" downward bend or loop in the cable. This will cause for that section of cable to be deeper, thereby avoiding the blades, as well as provide for some level of flexibility when the slab expands and contracts during the various seasons.
5.Place the mat or cable down on top of a "re-mesh" type lightweight wire mesh. This will facilitate the even spacing of loose cable or prevent mats from moving around during pour. Use Warmup-provided zip-ties to secure the mats or cables to the mesh.
6. Depending on the depth of the pour, plan on elevating the mesh holding the cable so that it sits 2" to 3" from the surface. You can also leave the mesh at the bottom of a 4" pour, but expect longer heat times.
7. Route the cold lead(s) through rigid PVC or metal conduit(s) to an accessible weatherproof junction box(es). Ensure that none of the factory splice or heated section of the cable enters any conduit. Do not use excess force to pull the cold leads otherwise it may damage the hot-cold splice. Seal the conduit ends.
8. Make the necessary provisions to plan for an in-ground sensor if applicable. Ensure you set it up such that the sensor will sit flush with the top coat of the concrete. A separate conduit should be used to protect the low voltage sensor wire and must NOT be shared with any high voltage cold lead from the mats/cables.
9. See various provisions regarding j-boxes and expansion joints. Provided all is set, you can pour the concrete through the lightweight mesh. Take the necessary precuations to avoid damaging the cable with spades/rakes during the pour.
10. An electrician MUST complete the final test and record results of all the mats/cables readings with a multi-meter and megohmmeter and verify that each mat/cable is in good working order and is ready for energizing once the sand has cured.
11. For easy reference, easy reference, tape your plan to a power distribution board, indicating the location of the heating cables.

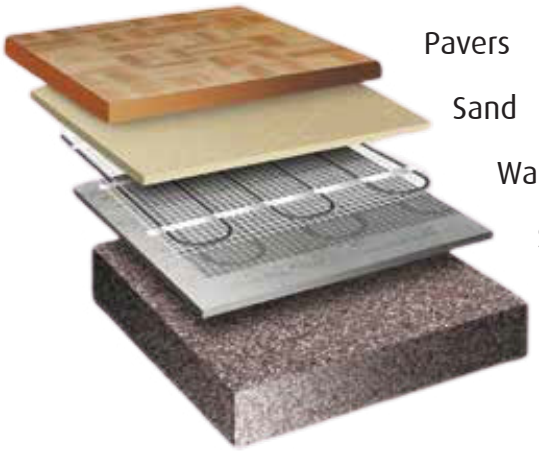
Installation Instructions - Loose Cables on Steps

The WARMUP Loose Cables are specifically designed to be applied on steps and landings. Here's how we recommend to proceed, using all the above-mentioned cautions and techniques.

1. We highly recommend the use of the WARMUP CLIP system (part number USM-FB1). Cut the strips to about 10" or the depth of the steps and apply every 2 or 3ft in width to maintain consistent spacing of the cables.
2. On a 10" deep step, use 3 runs of the loose cable, ensuring that one of the runs is at the outer-most edge of the step. This is to guarantee that the heating will perform even when stones are laid with an overhang on the step. For any unusual layouts or masonry work, please contact WARMUP.
3. Start your work closest to the 1" conduit provided to route the lead wire. This can be at the top of the landing or at the bottom of the steps. Work your way up or down from there.
4. When transitioning to the next step, manually apply a 90 degree bend to the cable, gently fighting the cable memory. Do not over-bend the cable. Going up or down to the next step, use a slightly diagonal route to reduce the bending radius to a minimum and when possible, lightly chisel the sharp edges of a concrete stair base.
5. Note whether the drawings will call for the installation of railings. If so, and because railings are drilled after the masonry or concrete work, leave a minimum of 6" on the edges of the steps.
6. Even when making use of the WARMUP CLIP system, we recommend the punctual application of hot glue with a hot glue gun to secure some of the manual bending and laying of the cable and clips.



Installation Instructions - Under Pavers



1. Ensure the paving contractor has a solid base of 4"-8" (102-203mm) of crushed rock aggregate tamped down and ready to receive the mortar pour or sand/gravel base.
2. Take extreme care to ensure the paver installer does NOT use any heavy equipment, machinery or vehicles over the exposed heating cables. We highly recommend the cable resistance be checked with a multimeter during the paving process. This will ensure detection of any unlikely faults as early as possible.
3. For installation on stairs and ramps that will include hand rails, it is strongly recommended that the paver installer pre-sleeves the posts to avoid any and all drilling of the mortar. The heating mat/cable must be routed around these sleeves or posts to avoid any direct contact with them. When preparing for railings, expansion joints and related, please ensure the contractor has clearly marked and informed the paving/ concrete contractor of the cable location.
4. Start by spreading a 1" layer of sand over the drained rock base. This will smoothen the base on which the mats/cables will be laid. Use landscape staples if permitted to secured your cables and mats in place. Where not suitable, use a lightweight mesh (type "re-mesh") to secured cable evenly spaced. Warmup recommends the used of WSMM Mats under pavers.
5. Route the cold lead(s) through metal or PVC conduit(s) to an accessible weatherproof junction box(es). The electrician must ensure that none of the heated section enters any conduit. For this type of application, we recommend the use of the built-in or aerial sensors to avoid cuts in pavers and stone. When using in-ground sensors, please make sure to plan ahead for correct placement of sensors within the stone. (Note: test the mats/cables to ensure they have not been damaged and record the readings.)
6. Do NOT walk on the hot-cold factory splice and avoid damaging the mats/cables with shovels or rakes. As with all installations, ensure the factory splice is embedded in sand or mortar, and not sleeved into a conduit.
7. The electrician needs to complete the final testing of all the snow melting mats/cables with a multi-meter to verify and record that each heating cable is still operational after the pour of mortar and cured. Record these values at the back of this manual.

Testing the Snow Melt Mat / Cable

A. Insulation Resistance (megohmmeter required)

1. Connect one meter clamp to the cold lead inner conductor and the other meter clamp to the metal cable braided sheath (ground) of the heating cable.

2. Test in accordance with the meter manufacturer's instructions (recommended meter is a 500 VDC megohmmeter).

3. Megohmmeter reading should read greater than 10 megohms.

4. Ensure you test and record readings BEFORE, DURING and AFTER installation.

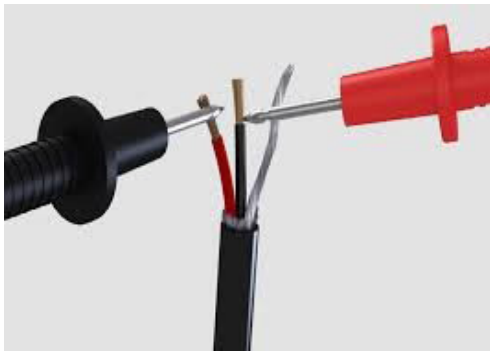
B. Total Cable Resistance (Multi-meter required)

1. Connect one meter clamp to one cold lead inner conductor and the other meter clamp to the other cold lead inner conductor.

2. Test in accordance with the meter manufacturer's instructions and record this Ohm value.

3. Total nominal cable resistance information is found in the Sizing Guide on page 1. Actual readings should be within 10% of the cable resistance.

4. Perform this test and record measured values on the Warranty Card BEFORE, DURING and AFTER installation.

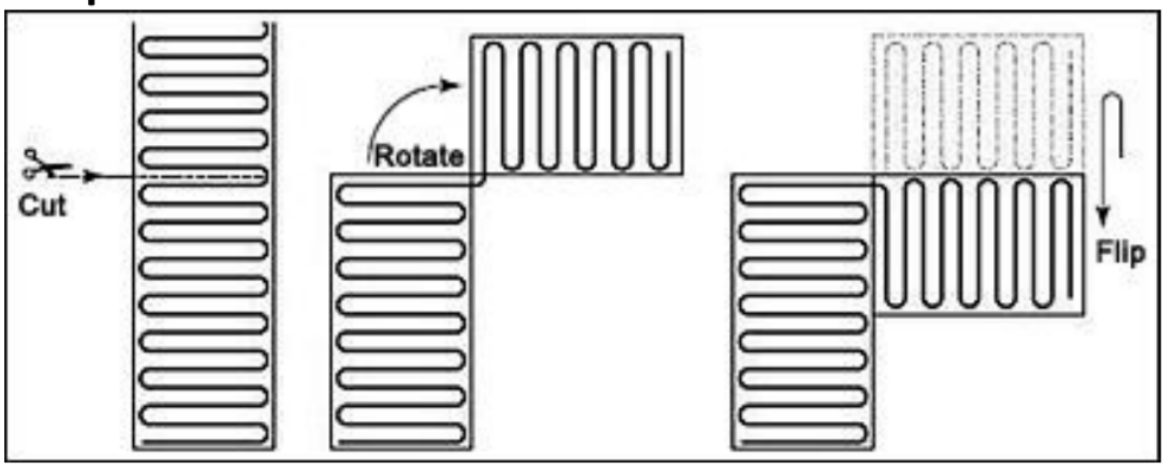


Accessories

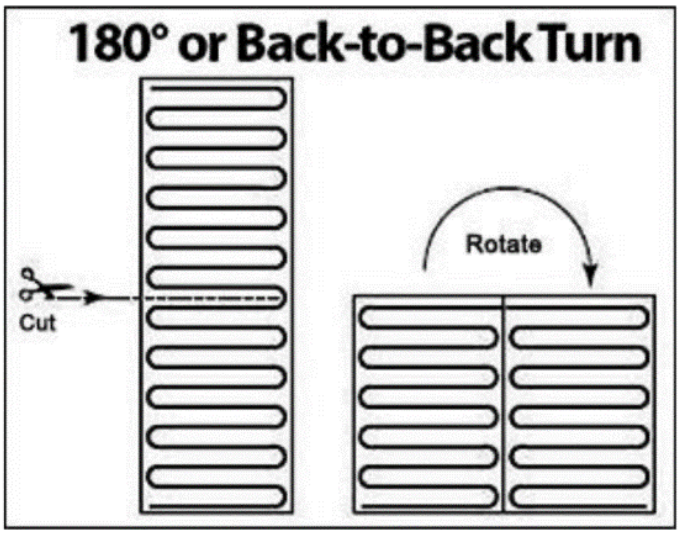
Code	Accessories
WSM-NMP	Branded Name Plate for use with Warmup Snow Melt Heater installations (NEC426-13).
ACC-DGMTR	The Alligator Tester - Digital Multimeter.
ACC-MEGG	Warmup's Digital Mega-Ohmmeter is used to track Insulation Resistance for installation Accuracy and Warranty Purposes.
SR-ZT-100	Bag of 100 Heavy Duty Zip Ties. 7" long. For use with WSM, WODH and NAMSR cable series. 50lbs load bearing capacity.
USM-FB1	Metal fixing strips to fix the heating cable - 83 ft long.

Applications with Mats

Flip Turn



180° or Back-to-Back Turn



WARRANTY - Snow Melting Mats and Cables

Warmup provides a 10-Year Warranty (from date of purchase) for the Snow Melting Mats and Cables for the material and workmanship under normal operating conditions.

In case of defective material, Warmup's obligation will be limited to the repair or supply of new material, free of charge to the customer.

The Warranty does NOT cover installations made by unqualified personal or faults caused by incorrect design by others; misuse; damage caused by others; damage in transit; incorrect installation and any other subsequent damage that may occur. Cost related to repair/replacement will be fully chargeable to the customer if the damage is due to any of the above reasons.

Warmup is under no circumstances liable for consequential damages or losses including without limitations the loss or profit arising from any cause whatsoever. The guarantee is a material warranty only and does NOT cover field labor. A qualified electrician MUST connect the heating system.

The Warranty is void if there is any payment default and if data is not filled in correctly.

EXCLUSIONS

Warmup, Inc. shall in no event be liable for incidental or consequential damages, including but not limited to extra utility expenses or damages to property. This Warranty is null and void if:

1) The covering over the heater(s) is damaged, lifted, replaced, drilled into or repaired.
2) The heater fails due to damage caused during installation, unless damage is caused directly by an employee of Warmup. It is therefore essential to check that the heater is working (as specified in the installation manual) prior and during installation.
3) Damage as a result of floods, fires, winds, lightning, accidents, corrosive atmosphere or other conditions beyond the control of Warmup, Inc.
4) Use of components or accessories is not compatible with Warmup heaters.
5) Warmup products are installed outside the United States.
6) Parts not supplied or designated by Warmup, Inc.
7) Damage or repair required as a result of any improper use, maintenance, operation or servicing.
8) Failure to start due to interruption and/or inadequate electrical service.
9) Any damage caused by frozen or broken pipes in the event of equipment failure.
10) Changes in the appearance of the product that does not affect its performance.
11) The owner, or his/her designated representative, attempts to repair the product without receiving prior authorization from Warmup. Upon notification of a repair problem, Warmup, Inc. will issue an Authorization to Proceed under the terms of this Warranty. If Warmup is required to inspect or repair any defects caused by any exclusions referenced above, all work will be fully chargeable at Warmup's inspection and repair rates then in effect.

WARMUP, INC. DISCLAIMS ANY WARRANTY NOT PROVIDED HEREIN, INCLUDED ANY IMPLIED WARRANTY OF THE MERCHANTABLE OR IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE. WARMUP, INC. FURTHER DISCLAIMS ANY RESPONSIBILITY FOR SPECIAL, INDIRECT, SECONDARY, INCIDENTAL, OR CONSEQUENTIAL DAMAGES ARISING FROM OWNERSHIP OR USE OF THIS PRODUCT, INCLUDING INCONVENIENCE OR LOSS OF USE. THERE ARE NO WARRANTIES THAT EXTEND BEYOND THE FACE OF THIS DOCUMENT. NO AGENT OR REPRESENTATIVE OF WARMUP, INC. HAS ANY AUTHORITY TO EXTEND OR MODIFY THIS WARRANTY UNLESS SUCH EXTENSION OR MODIFICATION IS MADE IN WRITING BY A CORPORATE OFFICER.
DUE TO DIFFERENCES IN BUILDING AND FLOOR INSULATION, CLIMATE AND FLOOR COVERINGS, WARMUP, INC. MAKES NO REPRESENTATION THAT THE FLOOR TEMPERATURE WILL ACHIEVE ANY PARTICULAR TEMPERATURE OR TEMPERATURE RISE. UL STANDARD LISTING REQUIREMENTS LIMIT THE HEAT OUTPUT OF WARMUP UNDERTILE HEATING, AS SUCH, USERS MAY OR MAY NOT BE SATISFIED WITH THE FLOOR WARMTH THAT IS PRODUCED. WARMUP DOES WARRANT THAT ALL HEATERS WILL PRODUCE THE RATED WATT OUTPUT LISTED ON THE HEATER NAMEPLATE, WHEN OPERATED AT THE RATED VOLTAGE.

TERMS AND CONDITIONS

Shipping Discrepancies:

Incoming materials should be inventoried for completeness and for possible shipping damage. Any visible damages or shortages must be noted prior to accepting the material. Any discrepancy concerning type or quantity of material shipped, must be brought to the attention of your Warmup® reseller within 15 days of the shipping date entered on the packing slip for the order.

Miscellaneous:

The terms of this Limited Warranty are exclusive and supersede any other warranty or terms and conditions relating to the subject matter whether included in a purchase order for this product or in any other document or statement.

Register your Warmup warranty at www.warmup.com or www.warmup.ca

Warmup Offices in North America:

USA: Warmup Inc | Tel 1-888-927-6333 | Fax 1-888-927-4721
E-mail us@warmup.com | Web www.warmup.com

Warmup®

The world's **best-selling** electric floor heating brand™

COMMBOX-600 | MULTI-ZONE SNOW MELTING CONTROLLER

SUBMITTAL SHEET WSC-0927

DESCRIPTION

The COMMBOX-600 is a "Plug and Play" controlled power distribution panel for frost protection, ice and snow melting applications.

When receiving a signal from the snow sensor/s (such as the AIRsense), it activates the contactors, energizing the heating elements.

Based on the DIP switches configuration, the zones are activated either continuously or in customized sequencing between the zones.

The adjustable *Hold-On* timer keeps the outputs to the zones active, to ensure complete snow melting.

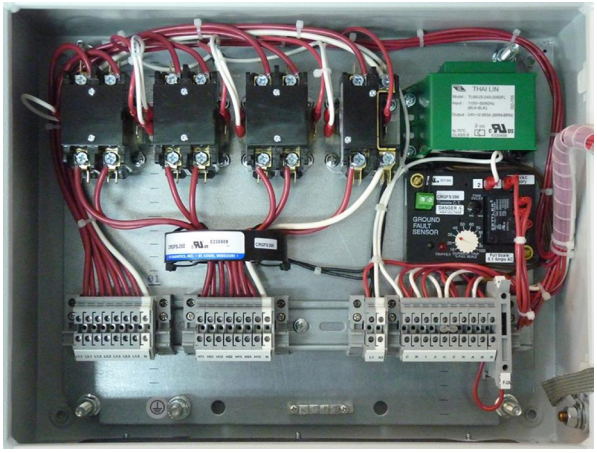
The *Hold-On* (Time delay) is adjustable in the range of up to 99 hours.

The outdoor temperature set-point, as well as ground Upper limit temperature and ambient lower limit temperature can be easily set.

The *Technician Settings* mode allows installer or technician to adjust the parameters for customized installations.

The COMMBOX-600 Built-in Ground Fault interuptor allows settings for the tripping current between 0.1 – 1.0 A.

The GFS adjustable time delay provides a simple and safe protection from nuisance tripping.



Commbox-600 panel

AIRsense sensor

WARMUP INC.
52 Federal Road Unit 1F
Danbury, CT 06810

Tel.: 1-888-927-6333 Fax: 1-888-927-4721
us@warmup.com
www.warmup.com

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COMMBOX-600 | MULTI-ZONE SNOW MELTING CONTROLLER

SUBMITTAL SHEET WSC-0927

FEATURES AND BENEFITS

- Automatic Power/Load Distribution
- Up to 5 zones, 600A
- GFEP Protection Built-in
- Sequencing allows sharing of minimum required power supply
- Multiple Snow Sensor inputs
- User-friendly interface
- Integrated Electronic Controller with backlit display
- Energy Efficient Algorithm
- ETL approved with UL approved components.

THE PARAMETERS THAT CAN BE MODIFIED ARE AS FOLLOW

- Temperature set point
- Lower ambient temperature limit
- Slab Upper Temperature Limit to deactivate heaters for Energy Efficiency
- Time delay (Hold-on) before deactivating the heaters
- ON time for Manual mode
- Heaters cycle time / Splitting time between zones
- Number of zones and sequence of operation (Sensors and heaters control logic)
- Snow sensor RH sensitivity
- Number of snow sensors connected

- DIP Switches located on the controllers provide easy access to technician mode and to the system configuration settings.
- A 5th output (277 VAC, 30A Max Single Phase) can be used as a stand-alone ice melting zone or be activated simultaneously with zone #4. The Zone #5 offers a simple option for gutter, roof ice-melting or critical zone.
- The COMMBOX-600 allows snow sensor input both from the sensors and also from a 3rd party snow sensors.
- 3 terminals in the COMMBOX-600 are available to connect a CIT-1™, GIT-1™ or SIT-6E™ sensors and use them to control some or all of the zones.
- Installing the system is a quick and easy task. Apart of mounting the metal box to the wall, the installer needs only to connect the line in and line out wires in the marked terminals and the system is ready to work.

LIMITATIONS

For effective and energy efficient snow melting installations, Warmup® does not recommend heating in more than two zones.

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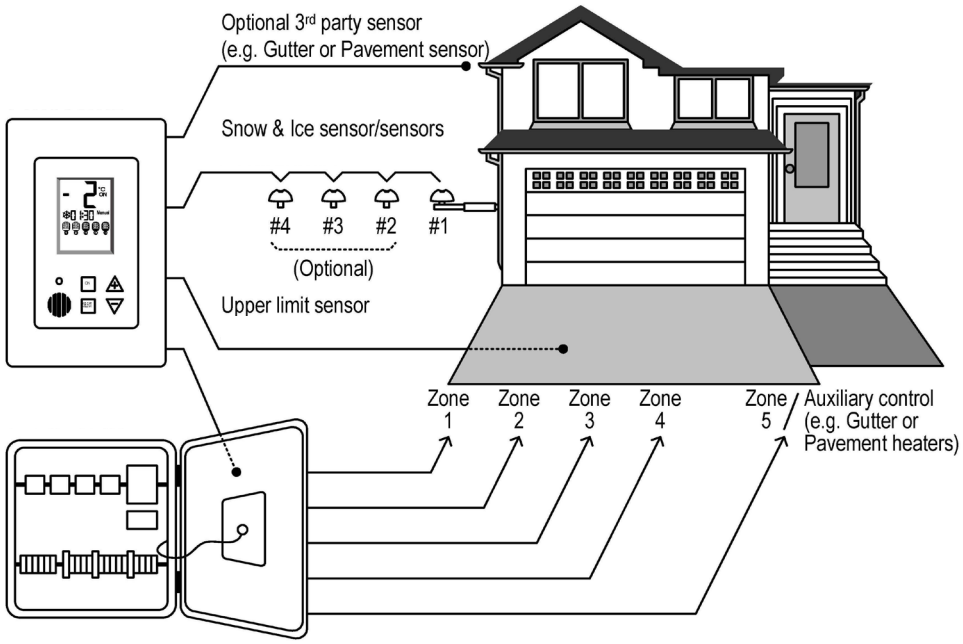
COMMBOX-600 | MULTI-ZONE SNOW MELTING CONTROLLER

SUBMITTAL SHEET WSC-0927

GENERAL SYSTEM LAYOUT



TECHNICAL SPECIFICATIONS

Approvals	ETL Listed CAN/CSA-C22.2 No. 14 | UL-508A
Enclosure Protection	IP20, Indoor Mounting
Dimensions	18x18x8 inch (50x50x25 cm)
Ground Fault	Adjustable trip current 0.1-1 A
Equipment Protection	(default 0.2A)
GFS	Adjustable time delay 0.1-1 sec. (default 0.1 sec.)
Manual Reset GFS	Push button on Front Panel
Four Satellite	600 VACS, 50 A Max
Contactors	(Resistive), 50/60 Hz, 3-Poles
One Satellite	277 VAC, 30 A Max (Resistive),
Contactor	50/60 Hz, 1-Pole 600 VAC / 50 A per pole
Terminal blocks	6 mm2 ,10 AWG (max)

RELATED PRODUCTS

- CIT1 - see WSC-1104
- GIT1 - see WSC-1204
- SIT6E - see WSC-1304
- APS3C - see WSC-1404
- AIRsense - see WSC-0205

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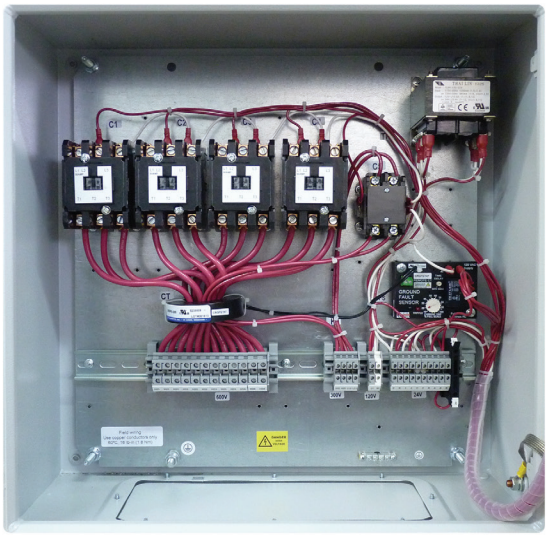
RESIBOX-120 AND COMMBOX-600 INSTALLATION INSTRUCTIONS

RESIBOX-120



COMMBOX-600

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RESIBOX-120 AND COMMBOX-600 INSTALLATION INSTRUCTIONS

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RESIBOX-120 AND COMMBOX-600 INSTALLATION INSTRUCTIONS

The power boxes together with the controller and interface panel, offer smart and easy control over the Snow & Ice Melting system.
It can operate up to 4 snow melting zones and one auxiliary zone, with selectable sequencing method. Typical applications include driveways, sidewalks, loading docks, stairs, pavements and gutters.

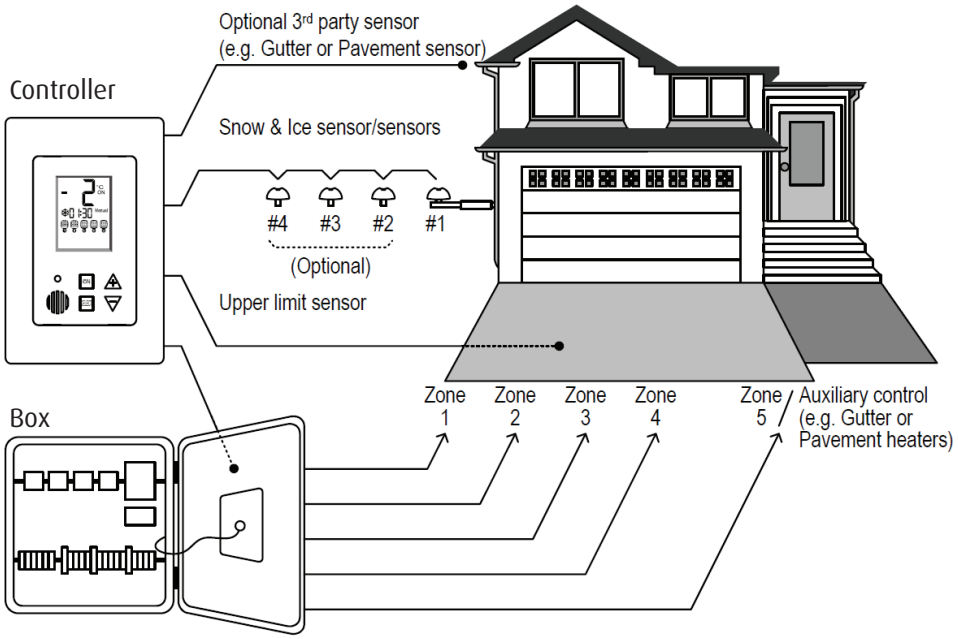
The backlit LCD screen provides full interface and information of the system status.

The use of several zones staggering allow covering larger area for snow melting with a limited available electrical power.

The controller offers various operating and programming options such as:

- Switchable temperature scales (°F or °C)
- Both Automatic and Manual modes
- Adjustable heaters cycle and splitting times
- Adjustable heaters hold on, off & delay
- Adjustable snow sensor sensitivity (%Rh)
- Optional auxiliary control by 3rd party snow sensor (e.g. Gutter sensor)
- Commissioning/Test mode
- Energy saving upper temperature limit
- Adjustable Lower ambient temperature limit to stop heaters (lockout)

General System Layout with Resibox-120 and Commbox-600



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PLEASE READ THIS MANUAL AND THE SAFETY WARNINGS CAREFULLY BEFORE INSTALLING AND USING THE CONTROLLER AND SAVE IT FOR FUTURE USE

INSTALLATION NOTES

- Familiarize yourself with the markings, warnings, components and terminology.
- The power boxes and its accessories must be installed by a qualified electrician in accordance with local regulations and the requirements of the NEC (NFPA 72) and the CEC part 1.
- **WARNING:** Ensure the power is disconnect from all circuits before mounting the power box and making any connections. Contact with components carrying hazardous voltage can cause electric shock and may result in severe personal injury or death.
- **Installer must ensure the installation of approved disconnect means, for all power supply circuits feeding this unit.**
- The power boxes are suitable for indoor wall mount installation only.
- Ensure wiring according to the provided schematics using copper conductors only.
- Make sure the wire gauge (AWG) is suitable for the circuit amperage draw, as specified in the NEC/CEC table 1.
- Ensure that the main breakers (fuses) are suitable for the heating systems rating (80% load).
- Grounding means must comply with local regulations and CEC/NEC.
- Ensure that the heating system/de-icing system connected to this unit complies with the UL 499 or UL 515 & CSA 22.2 # 130.3 standard and is certified / listed by an NRTL.
- Ensure that all wiring is rated for the application at 60°C (140°F as per UL 515 CSA 22.2 #130 clause 12 table 12.1).
- Ensure that any holes punched for conduit are to compromise the integrity of the enclosure ratings.

GROUND FAULT CIRCUIT INTERRUPTER (GFCI)

- The ground fault interrupter/residual current detector installed in this system is a Non class A GFCI, intended for equipment protection.
- Familiar yourself with its operation and required setting.
- At installation and commissioning stage use a calibrated milliamp meter to read and record the heating systems natural leakage.
- Set the GFI/RCD to no more than 30 milliamps higher than that reading.
- This step might have to be repeated a few times, to avoid nuisance tripping.
- The GFCI should be tested monthly. Please refer to the calibration and testing instructions in appendix 1 of this manual.

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WIRING THE COMMBOX-600

Heater load connection

- Provide 3-Phase contactors C1, C2, C3 and C4 with up to 600 VAC, 50 AMP Maximum per pole.
- Provide contactor C5 with with up to 277 VAC, 30 AMP.
- Make sure the wire gauge (AWG) is suitable for the circuit Amperage draw, as specified in the NEC/CEC table 1.

Main supply for the power box

- Provide terminals L1, N1 with 120 VAC supply.

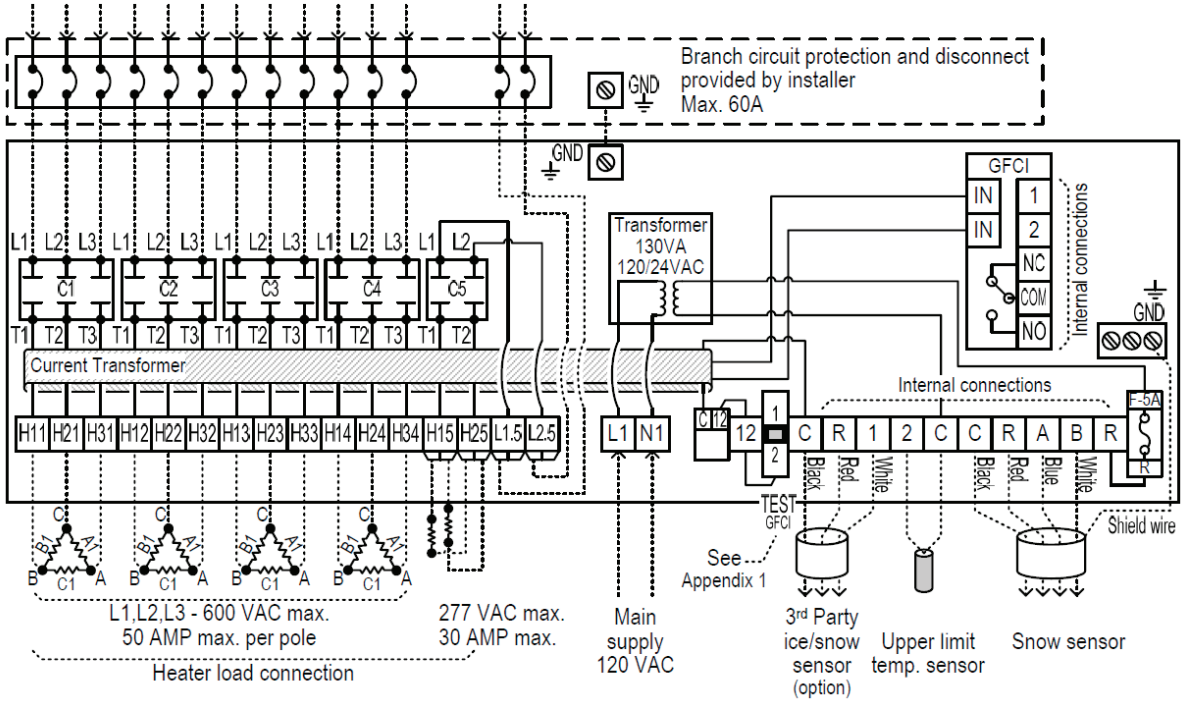
CAUTION: INCORRECT VOLTAGE MAY CAUSE FIRE OR SERIOUSLY DAMAGE THE UNIT

Connection to 3rd party ice/snow sensor (GIT-1 / CIT-1 / SIT/6E) - option

- 3-wire shielded cable
- Up to 2,000 ft (609 m) using 12 AWG 3-wire shielded cable.
- Up to 500 ft (152 m) using 18 AWG 3-wire shielded cable.

Connection to snow sensor AIRSense.

- Please refer **AIRSense** installation section of this manual.



IMPORTANT: If the heaters are connected in stars, the neutral must pass through the internal current transformer ring and the external branch circuit protection.

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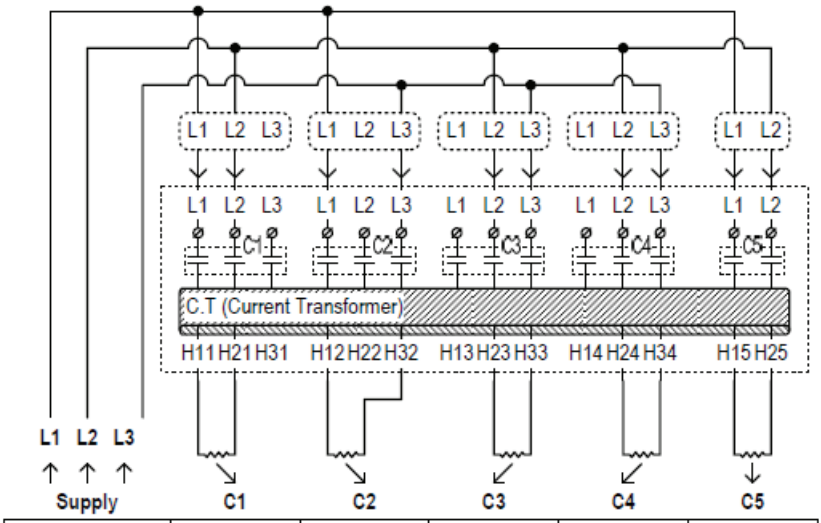
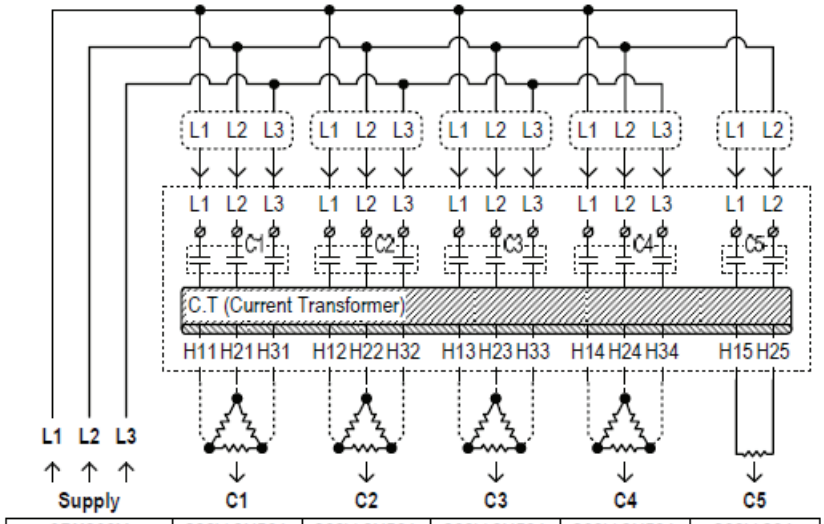
Option 1: 1 heater per contactors C1, C2, C3, C4 and C5



3PX208V	208V,50A	208V,50A	208V,50A	208V,50A	208V,30A
3PX347V	347V,50A	347V,50A	347V,50A	347V,50A	N/A
3PX480V	480V,50A	480V,50A	480V,50A	480V,50A	N/A
3PX600V	600V,50A	600V,50A	600V,50A	600V,50A	N/A

Option 2: 3 heaters per contactors C1, C2, C3 and C4 (triangle transform) and 1 heater per contactor C5



3PX208V	208V,3X50A	208V,3X50A	208V,3X50A	208V,3X50A	208V,30A
3PX347V	347V,3X50A	347V,3X50A	347V,3X50A	347V,3X50A	N/A
3PX480V	480V,3X50A	480V,3X50A	480V,3X50A	480V,3X50A	N/A
3PX600V	600V,3X50A	600V,3X50A	600V,3X50A	600V,3X50A	N/A

Note: Contactors 1 and 2 can be connected to any combination of 1 or 3 (triangle transform) heaters. Example: Contactor C1 can be connected to 3 heaters (triangle transform) and contactor C2 can be connected to 1 heater.

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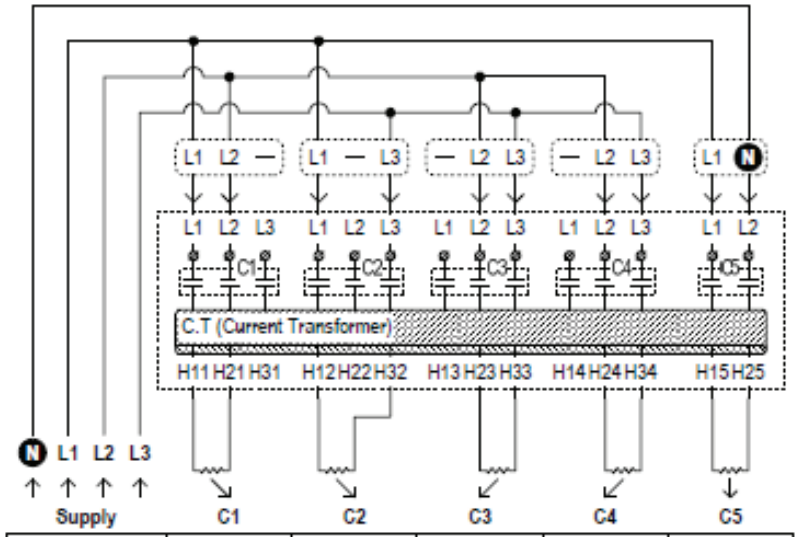
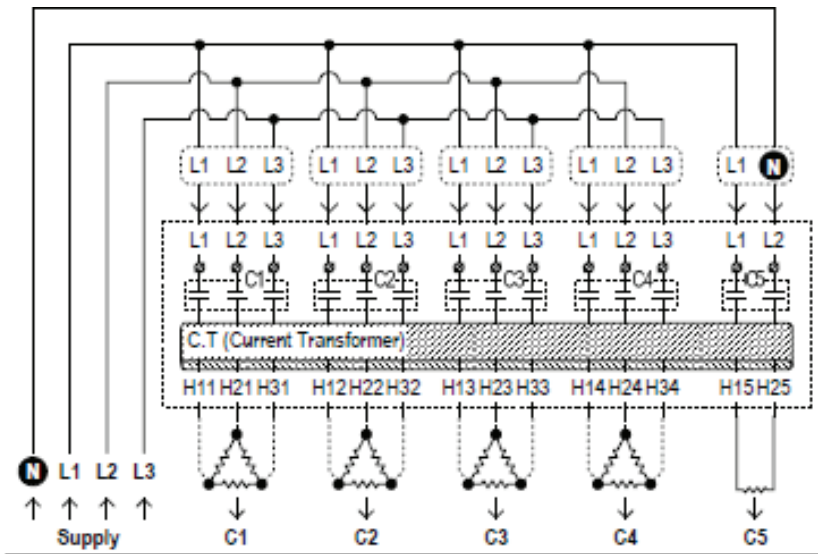
Option 1: 1 heater per contactors C1, C2, C3, C4 and C5



3PX208V + N	208V,50A	208V,50A	208V,50A	208V,50A	120V,30A
3PX347V + N	347V,50A	347V,50A	347V,50A	347V,50A	200V,30A
3PX480V + N	480V,50A	480V,50A	480V,50A	480V,50A	277V,30A
3PX600V + N	600V,50A	600V,50A	600V,50A	600V,50A	N/A

Option 2: 3 heaters per contactors C1, C2, C3 and C4 (triangle transform) and 1 heater per contactor C5



3PX208V + N	208V,3X50A	208V,3X50A	208V,3X50A	208V,3X50A	120V,30A
3PX347V + N	347V,3X50A	347V,3X50A	347V,3X50A	347V,3X50A	200V,30A
3PX480V + N	480V,3X50A	480V,3X50A	480V,3X50A	480V,3X50A	277V,30A
3PX600V + N	600V,3X50A	600V,3X50A	600V,3X50A	600V,3X50A	N/A

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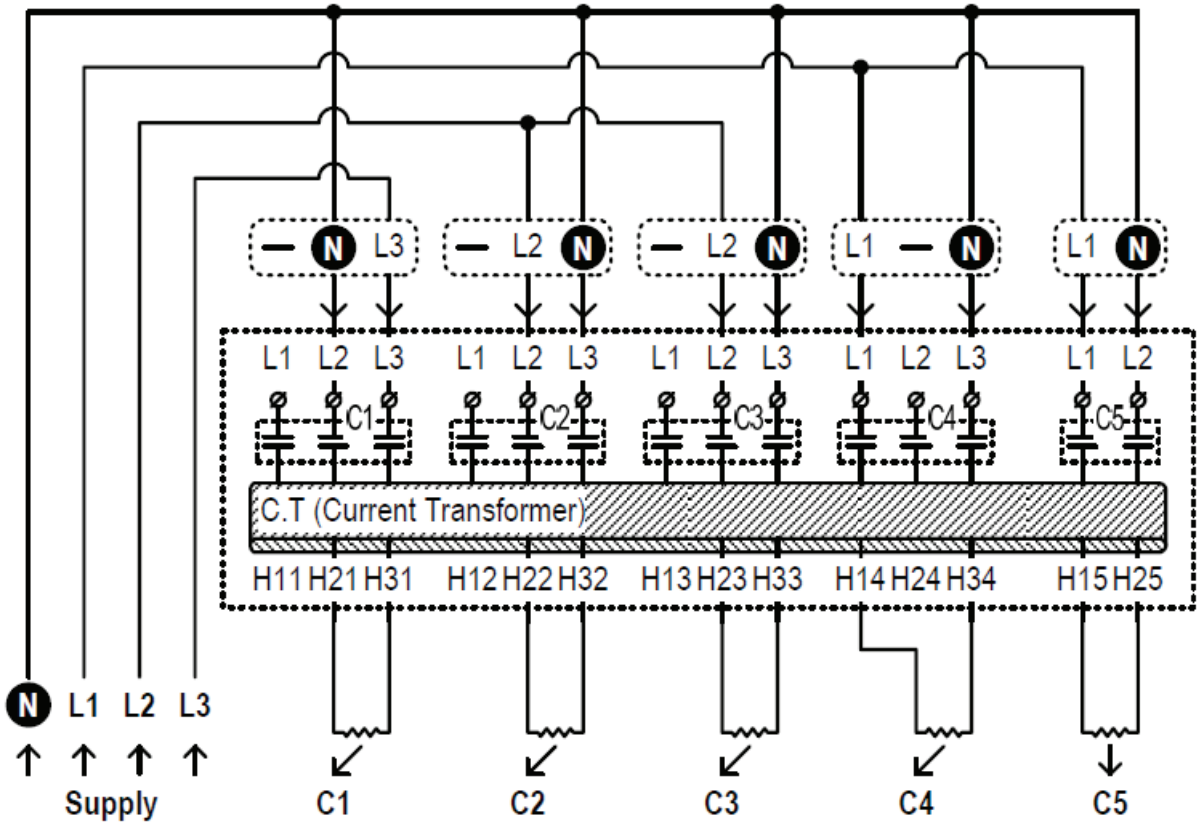
Option 3: 1 heater per contactors C1, C2, C3 and C4 and C5 (Neutral connected to C1, C2, C3, C4 and C5)



3PX208V + N	120V,50A	120V,50A	120V,50A	120V,50A	120V,30A
3PX347V + N	200V,50A	200V,50A	200V,50A	200V,50A	200V,30A
3PX480V + N	277V,50A	277V,50A	277V,50A	277V,50A	277V,30A
3PX600V + N	347V,50A	347V,50A	347V,50A	347V,50A	N/A

Note: Contactors 1,2,3 and 4 can be connected to any combination of 1 or 3 (triangle transform) heaters with and without Neutral.

Example: Contactor C1,C2 and C3 connected to 3 heaters (triangle transform) and contactor C2 connected to 1 heater.

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WIRING THE RESIBOX-120

Heater load connection

- Provide contactors C1, C2, C3 and C4 with up to 277 VAC, 30 AMP.
- Make sure the wire Gauge (AWG) is suitable for the circuit Amperage draw, as specified in the NEC/ CEC table 1.

Main supply for the power box

- Provide terminals L1, N1 with 120 VAC supply.

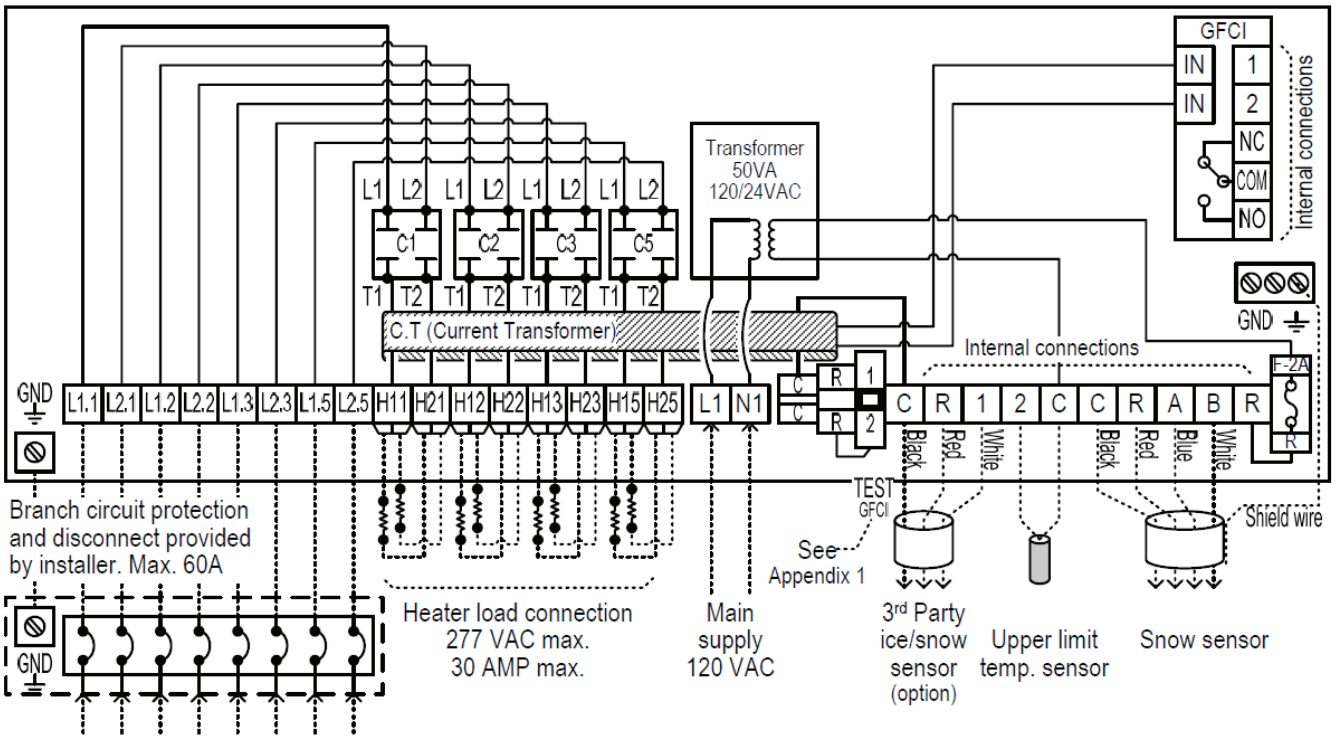
CAUTION: INCORRECT VOLTAGE MAY CAUSE FIRE OR SERIOUSLY DAMAGE THE UNIT

Connection to 3rd party ice/snow sensor (GIT-1 / CIT-1 / SIT/6E) - option

- 3-wire shielded cable
- Up to 2,000 ft (609 m) using 12 AWG 3-wire shielded cable.
- Up to 500 ft (152 m) using 18 AWG 3-wire shielded cable.

Connection to snow sensor (AIRSense)

- Please refer AIRSense installation section of this manual.



IMPORTANT: If the heaters are connected in stars, the neutral must pass through the internal current transformer ring and the external branch circuit protection.

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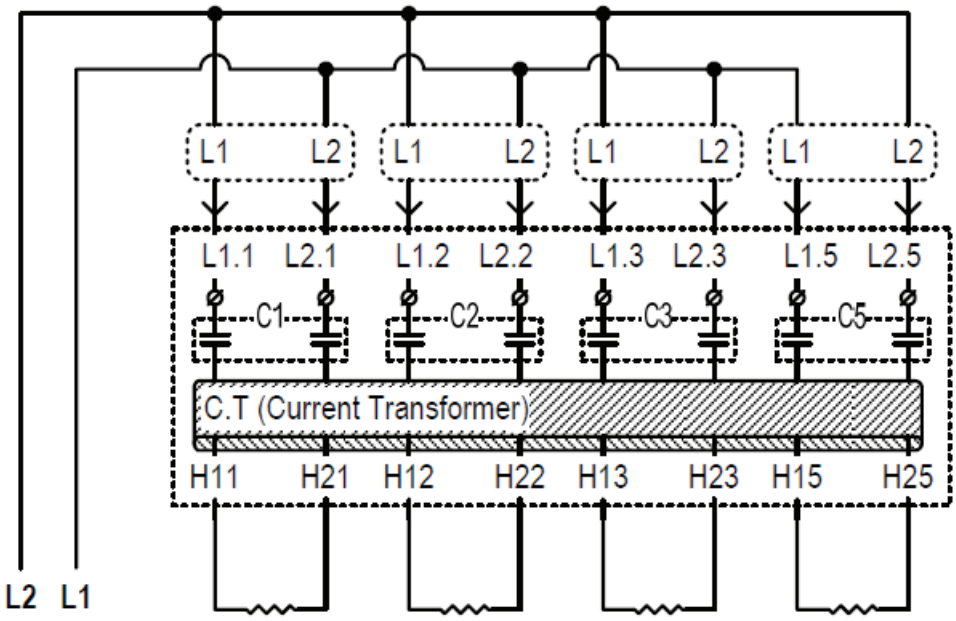
Option 1



120V	120V,30A	120V,30A	120V,30A	120V,30A
240V	240V,30A	240V,30A	240V,30A	240V,30A

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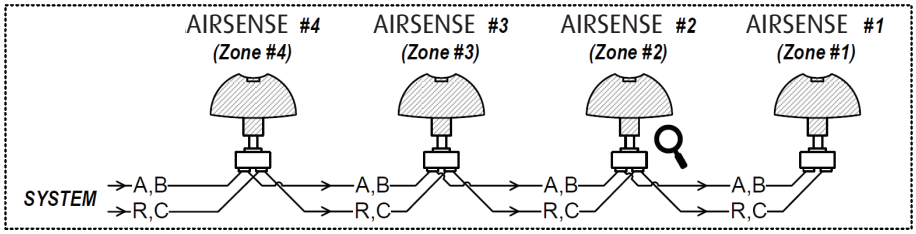
CONNECTING SNOW SENSORS TO THE SYSTEM

The system can be configured to operate with 1, 2, 3 or 4 snow sensors.
Each snow sensors must have different MAC address in order to communicate with the main board.
The snow sensors series includes 4 different part numbers, each is factory pre-configured with unique MAC address as follows:

AIRSense1	MAC Address 1	AIRSense2	MAC Address 2
AIRSense3	MAC Address 3	AIRSense4	MAC Address 4

When connecting more than one sensor, snow sensor 1 must be connected last in communication line.



The snow sensors will control zone upon the following logic:

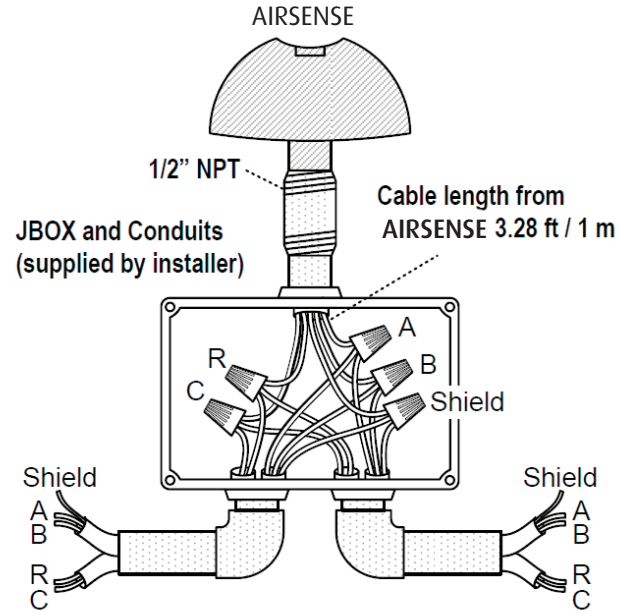
Connecting 1 snow sensor
The snow sensor will control all 4 zones (and zone 5 as an option).

Connecting 2 snow sensors
Snow sensor 1 will control zones 1 and 2.
Snow sensor 2 will control zones 3 and 4 (and zone 5 as an option).

Connecting 3 snow sensors
Snow sensor 1 will control zone 1.
Snow sensor 2 will control zone 2.
Snow sensor 3 will control zones 3 and 4 (and zone 5 as an option).

Connecting 4 snow sensors
Snow sensor 1 will control zone 1.
Snow sensor 2 will control zone 2.
Snow sensor 3 will control zone 3.
Snow sensor 4 will control zone 4 (and zone 5 as an option).

Notes:
- The number of snow sensors connected must be configured in section P09 of the technician settings.
- When one of the snow sensors cannot be viewed through communication (faulty or not connected), the values on snow sensor 1 will be used instead.



Communication cable (A,B)
Jacketed shielded twisted pair, 120 Ohm, 18AWG
Up to 500 ft / 150 m
Power cable (R,C)
18AWG - Up to 500 ft / 150 m, 12AWG – Up to 1000 ft / 300 m

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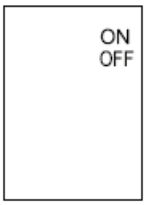
OPERATING INSTRUCTIONS

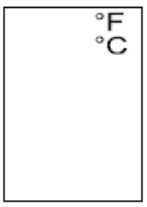
Green POWER lamp
- The green power lamp will light when power is supplied to the unit (120 VAC).

Red GROUND FAULT RESET lamp and button
- The red GROUND FAULT RESET lamp will lit when the internal GFCI is tripped.
- Press and hold the GROUND FAULT RESET button for 5 seconds to reset the unit.

Turning the system ON and OFF
- Press and hold the [ON] button for 0.5 seconds to turn the system ON or OFF.
- The words "ON" or "OFF" will appear on display.

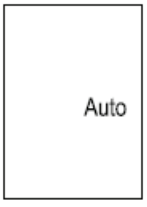


Selecting temperature scale
- Press the [+] button for Celsius.
- Press the [-] button for Fahrenheit.



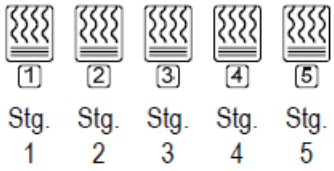
Selecting Automatic or Manual mode
- Press the [SELECT] button to switch between modes:

"Automatic"
Heating will start and stop automatically depending on snow detection by the snow sensor/ sensors.
"Manual ON"
Heating will start regardless of snow sensor measurements and will stop after a preset time (pls. refer to the "Manual ON" section in the technician settings P05).



NOTE: Mode will always return to "Automatic" after switching the unit OFF and ON.

Heaters indication
The number beneath the heater icon indicate the heater stage (1 to 5).



Black icon – Heater ON
White icon – Heater OFF

Snow flake icon and digital time indication
A solid snow flake icon will appear on display while sensing snow and during normal heaters operation.

A blinking snow flake icon will appear on display during heaters off delay or when manual mode is activated. The digital clock will count down the remaining time until the heaters are turned off. The snow flake icon will disappear from display as long as the heaters are turned off.

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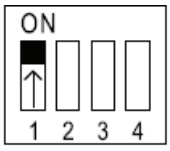
TECHNICIAN SETTINGS

Use the technician settings mode to view and adjust the following parameters:

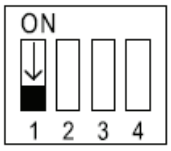
P01 Temperature set point
P02 Lower ambient temperature limit to stop heaters
P03 Energy saving, upper slab temperature limit to stop heaters
P04 Time delay before stopping the heaters
P05 ON time for manual mode
P06 Heaters cycle time / Splitting time
P07 Sensors and heaters control logic
P08 Snow sensor sensitivity
P88 Snow detection threshold
P09 Number of snow sensors connected
P10 Commissioning / Test mode
Restore defaults

Enter technician settings mode



- Move DIP switch S1 located on the side of thermostat to ON position.
- Press the [SELECT] and [+] buttons simultaneously to move forward to the next technician parameter.
- Press the [SELECT] and [-] buttons simultaneously to return to the previous technician parameter.

Save changes and exit technician settings mode



- Move DIP switch S1 located on the side of thermostat to OFF position.

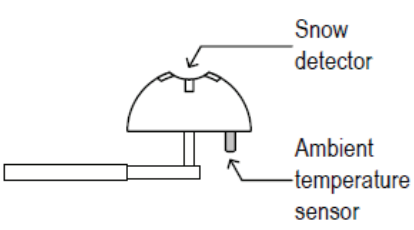
Important: Changes made to technician parameters will not take effect as long as DIP switch S1 is in ON position.

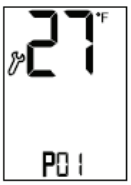
PARAMETERS:

P01 - Temperature set point

- Move DIP switch S1 located on the side of thermostat to ON position to enter technician settings mode.

- "P01" and the temperature set point will appear on display. Use the [+] and [-] buttons to adjust the temperature set point. Range: 19...45°F/ -7...+7°C.





Temperature set point

As long as the ambient temperature is lower than the temperature set point P01, the controller will turn ON upon receiving a positive snow signal from the snow detector.

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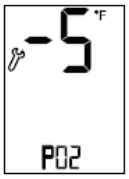
TECHNICIAN SETTINGS (CONT')

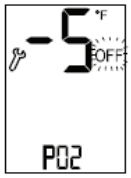
P02 - Lower limit temperature for heating

- Press the [SELECT] and [+] buttons simultaneously.
- "P02" and the low limit temperature will appear on display.
- When the temperature on the temperature sensor drops below the low temperature limit, the heating system will stop.
- Use the [+] and [-] buttons to adjust the temperature set point.
- Range: -4...+23°F / -20...-5°C Default: -5°F / -20°C
- Press the [SELECT] and [+] buttons simultaneously again.
- The word "ON" or "OFF" will appear on display.
- Use the [+] and [-] buttons enable (ON) or disable (OFF) the P02 parameter.If disabled, the heating system will operate without low temperature limitations.



Low limit Temperature

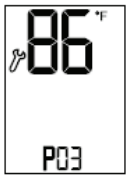
P02 enabled



P02 disabled

P03 – Upper limit temperature for heating

- Press the [SELECT] and [+] buttons simultaneously.
- "P03" and the slab upper limit temperature will appear on display.
- Use the [+] and [-] buttons to adjust the upper limit temperature.
- Range: +41...+86°F / +5...+30°C Default: 86°F / +30°C
- Press the [SELECT] and [+] buttons simultaneously again.
- The word "ON" or "OFF" will appear on display.
- Use the [+] and [-] buttons enable (ON) or disable (OFF) the P03 parameter.
- If disabled, the heaters will work regardless of the upper limit.
- Press the [SELECT] and [+] buttons simultaneously again.
- The display will show the temperature on the upper limit sensor.



Upper limit temperature

Set point enabled

P03 disabled

temperature on heaters sensors

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TECHNICIAN SETTINGS (CONT')

P04 -Time delay before stopping the heaters

- Press the [SELECT] and [+] buttons simultaneously.
- "P04", "dL" and the time delay before stopping the heaters (Hold ON) will appear on display. The hours will blink.
- Use the [+] and [-] buttons to adjust the hours of the time delay.
- Range: 00...99 hours Default: 00 hours
- Press the [SELECT] and [+] buttons simultaneously again.
- The minutes will blink.
- Use the [+] and [-] buttons to adjust the minutes of the time delay.
- Range: 00...59 minutes Default: 30 minutes

Time delay hours

Time delay minutes

Note 1. The time delay countdown will start when the snow detection signal from snow sensor will switch from positive to negative.
Note 2. The staggering sequence will continue during the time delay period.

P05 - Manual mode ON time

- Press the [SELECT] and [+] buttons simultaneously.
- "P05", "On" and the "Manual ON" mode time period will appear on display. The hours will blink.
- The delay time parameter defines a time frame in which the heaters remain ON after receiving an "Manual ON" command.
- Use the [+] and [-] buttons to adjust the hours of the working time.
- Range: 00...99 hours Default: 6 hours
- Press the [SELECT] and [+] buttons simultaneously again.
- The minutes will blink.
- Use the [+] and [-] buttons to adjust the minutes of the working time.
- Range: 00...59 minutes Default: 00 minutes

Manual ON hours

Manual ON minutes

P06 – Heaters cycle and splitting time

- Press the [SELECT] and [+] buttons simultaneously.
- "P06", "SP" and the splitting time will appear on display.
- The minutes will blink.
- The heaters cycle / splitting time parameter defines the working time of the heaters when working in sequence.
- Example: the splitting time is set to 10 minutes and 4 heaters work in sequence, each heater will be ON for 2.5 minutes (10/4=2.5).
- Use the [+] and [-] buttons to adjust the splitting time.
- Range: 10...1999 minutes Default: 24 minutes.

Splitting time

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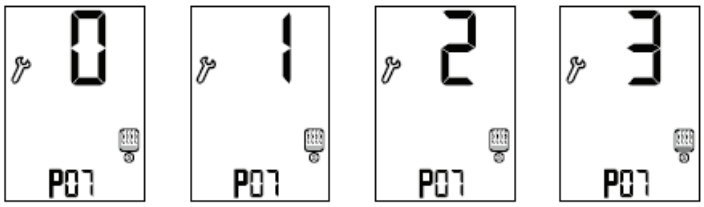
TECHNICIAN SETTINGS (CONT')

P07 - Heaters outputs logic controlled by AIRSense snow melt sensor or by 3rd party sensor

- Press the [SELECT] and [+] buttons simultaneously.
- "P07" and the figures "0", "1", "2" or "3" will appear on display.
- Use the [+] and [-] buttons to define the heaters logic (model dependent) as follows:



RESIBOX-120 *Outputs 1,2,3 and 5*

Value	Outputs controlled by AIRSsense	Outputs controlled by 3rd party sensor	Comments
0	All outputs	-	Default
1	1,2,3	5	
2	-	All outputs	The display will not show the ambient temperature and will remain blank.
3	Same as 1		

COMMBOX-600 *Outputs 1,2,3,4 and 5*

Value	Outputs controlled by AIRSsense	Outputs controlled by 3rd party sensor	Comments
0	All outputs	-	Outputs 4 and 5 will turn ON or OFF together. Default.
1	1,2,3,4	5	
2	-	All outputs	The display will not show the ambient temperature and will remain blank.
3	1,2,3	4,5	Outputs 4 and 5 will turn ON or OFF together.

Note: 3rd party sensors - i.e. gutter or pavement sensors – CIT, GIT, SIT by eti.

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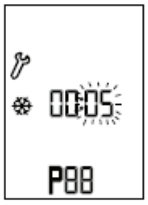
TECHNICIAN SETTINGS (CONT')

P08 - Snow sensor sensitivity

Snow sensor sensitivity

- Press the [SELECT] and [+] buttons simultaneously.
- "P08" and the snow sensor sensitivity value will appear on display.
- Use the [+] and [-] buttons to adjust the sensitivity.Range: 20...80 % (20% - Less sensitive, 80% - more sensitive), Default: 50 %

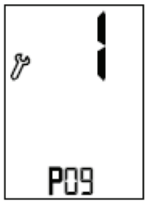
P88 - Snow detection threshold



Snow detection threshold

- Press the [SELECT] and [+] buttons simultaneously.
- "P88" and the snow sensor threshold will appear on display.
- Use the [+] and [-] buttons to adjust the threshold.
- Range: 00...60 minutes Default: 5 minutes
- If the threshold is not reached, the logic of turning the heaters either ON or OFF will not be affected by snow detection.
- During countdown to threshold time, the snow flake icon will flash.

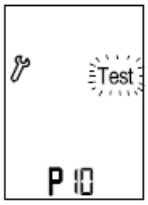
P09 – Number of snow sensors connected



Number of snow sensors

- Press the [SELECT] and [+] buttons simultaneously.
- "P09" and the number of snow sensors connected will appear on display.
- Use the [+] and [-] buttons to select 1, 2, 3 or 4 snow sensors. Default: 1

P10 - Test conditions mode / Technician commissioning mode



Test conditions mode

- Turn ON test conditions to check the functionality of the system regardless of sensors parameters (i.e. during the summer).
- In test conditions, the Ambient temperature is always -5°C/23°F.
- **Note**: In order to trigger the system and activate the heaters, use some water to wet the circuit on top of the snow sensor.
- Press the [SELECT] and [+] buttons simultaneously.
- "P10" will appear on display. The hours will blink.
- Use the [+] button to enter test/commissioning mode – "Test" will appear on display.
- Use the [+] button to manually exit test/commissioning mode – "Test" will disappear from display.

Note: If the technician did not manually exit test/commissioning mode, the unit will automatically return to normal mode after 5 hours.

In order to save changes and return to normal display, move DIP switch S1 back to OFF position.

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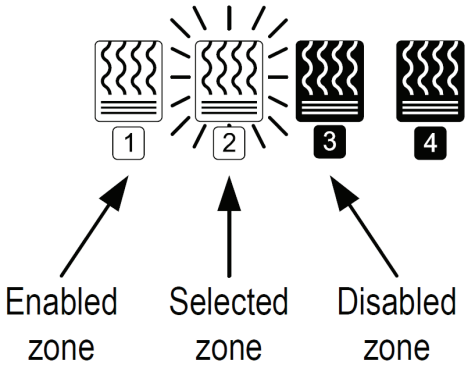
TECHNICIAN SETTINGS (CONT')



Restore default values

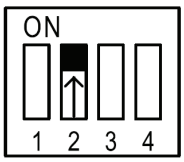
- Move DIP switch S1 to ON position.
- Press and hold the [ON] button for 10 seconds. The thermostat will beep.
- Move DIP switch S1 back to OFF position.

Enable/Disable zones

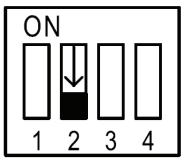
- Turn the unit OFF.
- While OFF, Press both the [+] and [-] buttons simultaneously for 10 seconds.
- Press the [Select] button to select zone. Selected zone will flash.
- Press the [+] and [-] buttons enable/disable the selected zone.
- Black icon and "ON" on LCD - Enabled zone.
- White icon and "OFF" on LCD - Disable zone.
- Press and hold the [+] and [-] buttons simultaneously for 5 seconds to exit.

Note: Disabled zones will be ignored in splitting time calculations:

Example: the splitting time is set to 60 minutes and heaters are set work in sequence.
3 Heaters enabled and 1 heater disabled.
With all heaters enabled: Each heater will be ON for 15 minutes (60/4=15).
With 3 heaters enabled and 1 heater disabled: Each heater will be ON for 20 minutes (60/3=20).



Short measuring times (test)



Normal operation

DIP switch S2 - Short measuring times (test only)

Use DIP switch S2 to short the measuring times as follows:
- "ON" - Short measuring times – for test/commissioning only (measuring times will be divided to 60).
- "OFF" - Normal operation.

Short measuring times:

A real 1 hour will take 1 minute and a real 1 minute will take 1 second.

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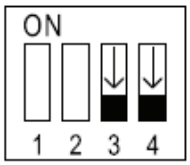
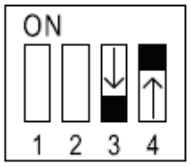
TECHNICIAN SETTINGS (CONT')

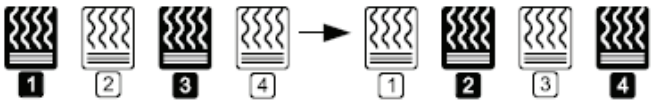
DIP switches S3 and S4 – heaters sequencing logic
Use DIP switches S3 and S4 to define the sequencing logic of the heater (zones) as follows:

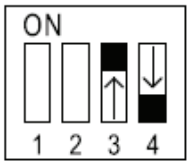


S3 OFF, S4 OFF
All 4 outputs work per request from the snow sensor(s)

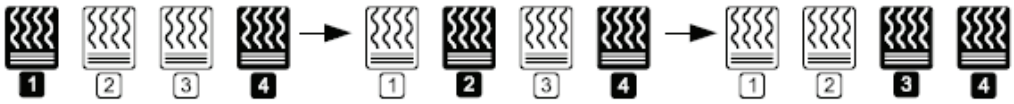


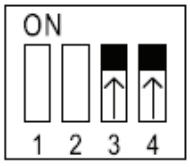
S3 OFF, S4 ON
Outputs 1+3 and outputs 2+4 work together (according to splitting time)
Note: Do not use this configuration with more than two snow sensors connected.



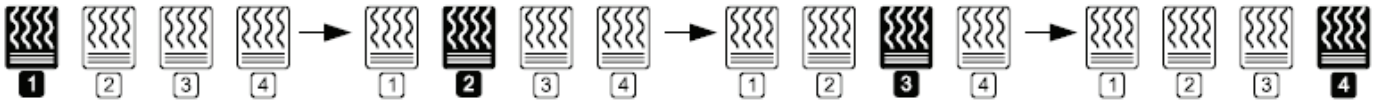


S3 ON, S4 OFF
Outputs 1,2 and 3 work in sequence (according to splitting time) and output 4 works continuously.
Note: Do not use this configuration with more than two snow sensors connected.





S3 ON, S4 ON
All 4 outputs work in sequence (according to splitting time)
Note: Do not use this configuration with more than two snow sensors connected.



NOTES:

1. The illustrations above show the heaters operation for the COMMBOX-600. The logic remains the same for RESIBOX-120, without heater 4.
2. Heater 5 for all models, will be activated with or without heater 4, depending on the "Heaters output logic" parameter set in section P07.
3. The logic will ignore disabled zones.

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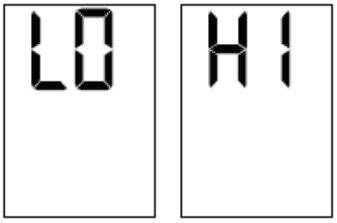
TEMPERATURE READING ERRORS

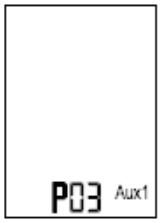


Ambient temperature sensor readings (on snow sensor) are out of reliable measuring range.

Ambient temperature < -9°F/-23°C
Ambient temperature > 54°F/12°C

The system will continue to operate using constant predefined values.
In addition, the display will alternate between "LO" and -11°F/-24°C for low temperature readings, and between "HI" and 55°F/13°C for high temperature readings.

Error 1 – Communication error with one (or more) snow sensors



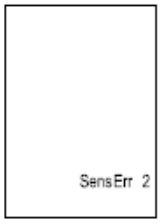
Communication error with snow sensors

"SensErr 1" Will appear on display.

If the system is configured to work with more than 1 snow sensor, the faulty snow sensor number will appear on display: P01, P02, P03 or P04.

The system will use readings from snow sensor 1 instead of the missing readings from the faulty snow sensor.

Error 2 – Upper limit temperature sensor is not connected or short circuit



Upper limit temperature Sensor error

"SensErr 2" Will appear on display.

The system will continue to operate regardless of the upper limit temperature.

Required actions:

1. Refer to P03 section of the technician settings.
2. Check the temperature value and disable the sensor if needed.
3. Replace the sensor.

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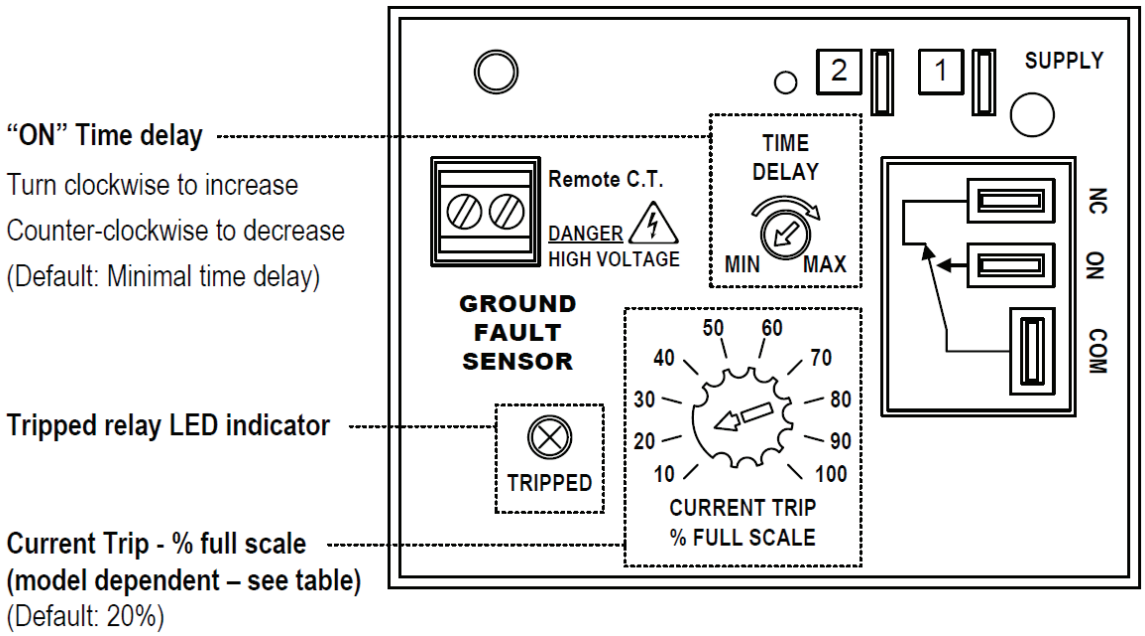
APPENDIX 1

Calibrating and testing the internal GFCI

The GFCI (ground fault circuit interrupter) is designed to provide protection for electrical equipment.

The "ON" Time Delay and Current Trip should be configured to match application requirements.



	Current trip (Amps)	
Indicator	COMMBOX-600	RESIBOX-120
10	0.1	1.0
20	0.2	0.02
30	0.3	0.03
40	0.4	0.04
50	0.5	0.05
60	0.6	0.06
70	0.7	0.07
80	0.8	0.08
90	0.9	0.09
100	1.0	0.10

GFCI TEST

The GFCI should be tested monthly. Press the red GFCI TEST button located next to the R,C terminals inside the box for 3 seconds to trip the outlet and break the circuit. The RED internal LED on the GFCI and the RED external lamp on the box door should lit. Press the RESET GFCI button on the box door for 5 seconds to return to normal operation and reestablish power and protection.

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UPPER LIMIT TEMPERATURE SENSOR

Description

The Upper Limit Temperature sensor is installed under the surface and measure the ground temperature. The temperature value sensed by the sensor if used by the Snow Melting controller in its algorithem for energy saving operation of the snow melting system.

The Sensor is connected to the Snow Melting Controller with a 30 feet (10 m.), 2 wires cable coated in a semi rigid polymeric material. The Semi rigid flexible cable enable the technician and installer to push the sensor into a long conduit without getting bended.

The temperature value of the sensor can be observed by the technician (in the Technician mode parameters of the controller) and the location of the sensor can be adjusted, based on the real-time reading.

In case of damage in the sensor (due to external force such as digging or drilling in the ground, damaging the cable), a warning notice on the controller LCD will indicate that the sensor is damaged and can be replaced.

** Included with Resibox-120/Commbox-600 purchase.
*** Does not replace ground level sensors such as SIT-6E or similar.

Features and Benefits

- Isolated NTC temperature thermistor
- 10KΩ @ 25°C
- 30 feet cable
- 24VAC
- Rated Voltage – 300V
- Semi rigid – enabels to be pushed into conduit
- Cable outer jacket color - Black
- Simple user interface for parameters set from the controller
- Technician testing / commissioning mode.
- Enables reading actual value

Cable length	33 ft. (10 m) two conductor cable
Installation	Underground inside a conduit
Material	Sensor – NTC thermistor Cable jacket – TPE
Resistance	10KΩ @ 25°C
Operating temp.	-40°F to 68°F (-40°C to 20°C)
Storage temp.	-50°F to 220°F (-40°C to 105°C)

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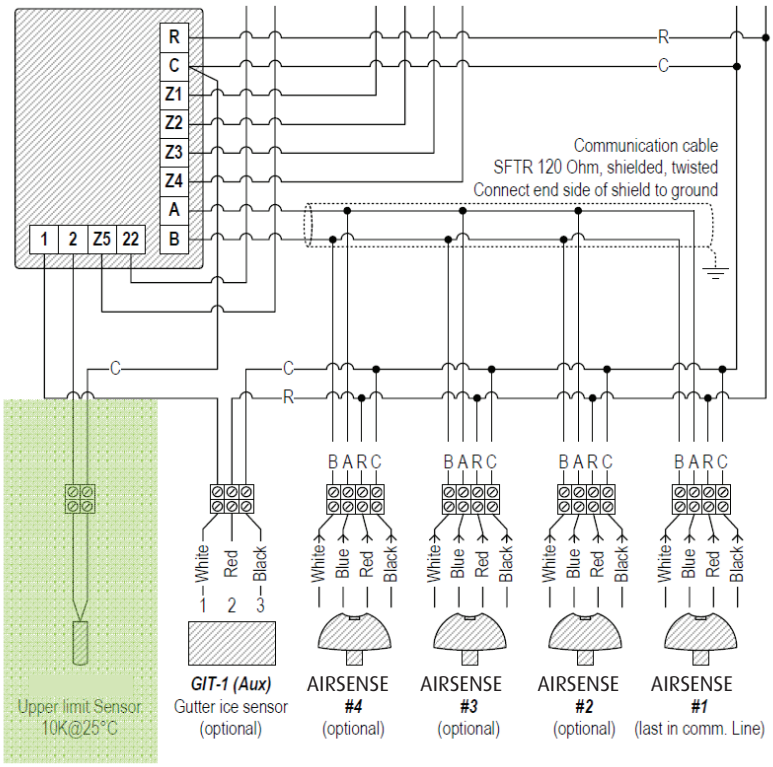
ELECTRIC DIAGRAM – CONNECTION TO THE BOX SYSTEM



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AIRsense | Aerial Snow Melting use with COMMBOX-600

Submittal Sheet WSC-0205

DESCRIPTION

The AIRsense is a stylish, smart and reliable Snow and Ice sensor. Installed outdoors it measures the temperature and detects snow, sending the information via the controller to the heating system.

The AIRsense is connected to the Snow Melting Controller with a 30 feet (10m.), 24V 4 wires cable and communicating with the controller, providing the temperature value and the snow detection based on the adjustable parameters.

The plastic 'igloo' shape design helps to assure reliable Snow/Ice detection as it prevents from the snow to accumulate around the sensing area. The 4 holes around the sensors were designed to hold the anti nesting spikes, keeping birds away from the sensor.

The sensor cap helps to keep the sensing area clean from dust and dirt during summer time and when the snow melting system is not used.

The measured temperature and the snow detection are visible on the backlit LCD display of the controller.

The system can work with up to 4 AIRsense - Snow Sensors chained one after the other and link the 4 output zones of snow melting to the AIRsense. A special sensor with pre-defined address is needed as an additional sensor besides the AIRsense who is active as #1.

AIRsense2, AIRsense3 and AIRsense4 are the required sensors when 2, 3 or 4 sensors are needed. Each snow sensors must have different MAC (Media Access Control) address in order to communicate with the main board.

FEATURES AND BENEFITS

- Electronic snow and ice sensor
- Plastic cover for off-season protection
- Plug & Play on COMMBOX-600 panels
- Adjustable set points
- Maintenance: Pre-Season test modes

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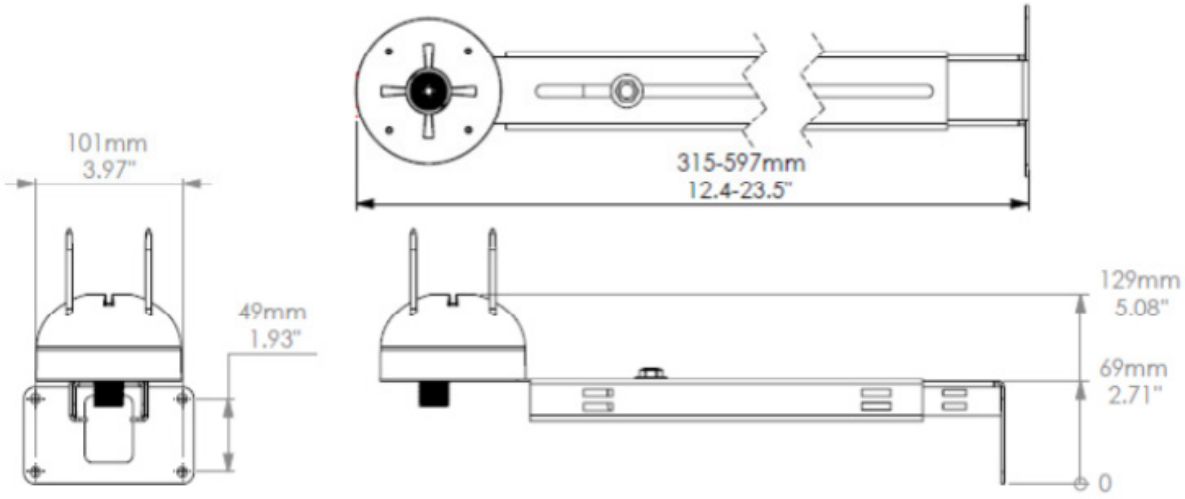
AIRsense | Aerial Snow Melting use with COMMBOX-600

Submittal Sheet WSC-0205

DIMENSIONS



TECHNICAL SPECIFICATIONS

Enclosure Protection	IP65, Outdoor Mounting
Entries	33 ft. (10 m) Four wires cable: • 2x18AWG supply wires • 2x22AWG communication wires optional: can be lengthened up to 450 ft. with extended wire
Mounting	Outdoor mounting on metal holder or vertical pole. NPT ½" Thread
Material	ASA WR9160
Supply	24VAC±20%,50-60Hz,4W
Communication	RS485
Operating temp.	-40°F to 122°F (-40° C to 50°C)
Storage temp.	–50°F to 158°F (–40°C to 70°C)

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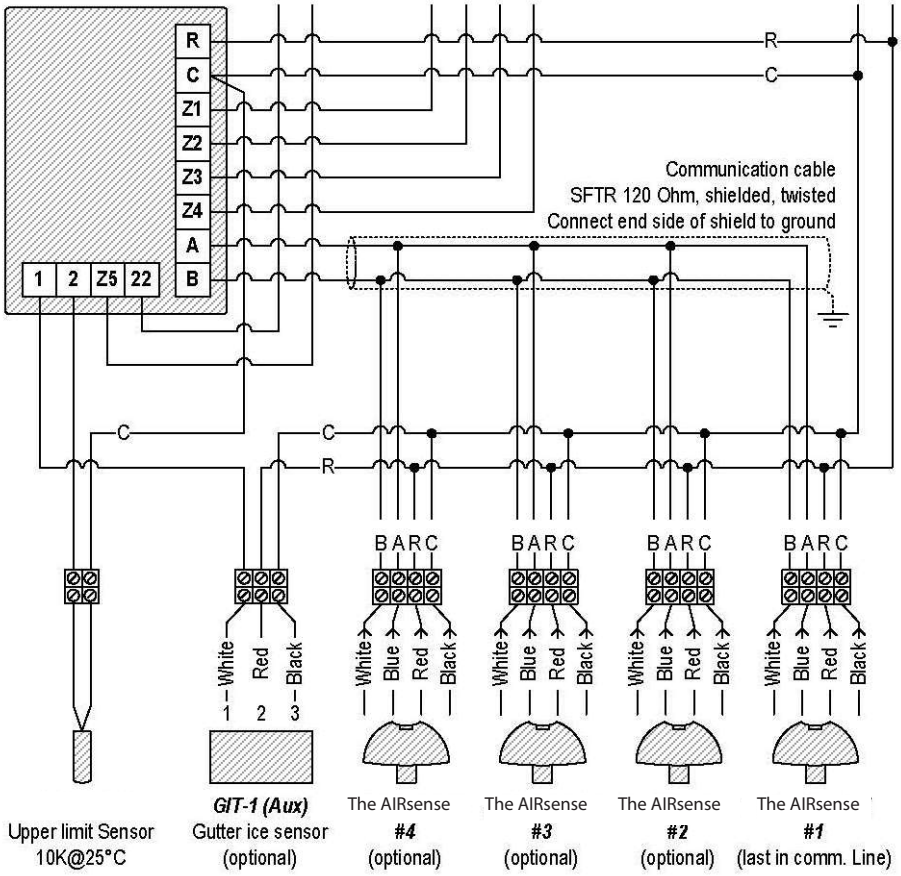
Submittal Sheet WSC-0205

WIRING DIAGRAM



The performance specifications are nominal and conform to acceptable industry standards. For applications at conditions beyond these specifications, consult the local Warmup office or representative. Warmup shall not be liable for damages resulting from misapplication or misuse of its products. This document is subject to change without any notice.

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DUAL CABLE TESTER
SUBMITTAL SHEET WSC-2209

PRODUCT CODE

DCT-1-SB

PRODUCT DESCRIPTION

This custom built tester is the fruit of years in the heating cable business. Installers rarely have the right tools to complete the job, required to take various ohms readings, yet find themselves with flimsy 'beepers'. The dual tester monitors up to two cables concurrently and monitors the integrity of both the core to core and core to ground resistance. Throughout the installa-tion it will provide a precise resistance reading and both flash and sound an alarm when the circuit is interrupted.

SPECIFICATIONS

- Up to 125 hours of operation while in use
- Low battery alert
- Suitable for cable gauge up to 13 AWG
- Flashes and sounds loudly
- Monitors two separate circuits concurrently
- Convenient hook to secure near electrical box
- Dims/Weight: (in carton): 140 x 84 x 32mm (~5x3x1"), 160 gr / 6 oz

OPERATIONS GUIDE

Power-up

- Insert 9V battery in rear of device. Upon activation, the red and green lights will flash 3 times. *Connecting Cables*
- Using the screw terminals at the bottom of the device, connect your heating cable or circuit following the Load (L), Neutral (N) and Ground (G) nomenclature. For voltages beyond 120V, use the Neutral slot as the second Load. Once connected, turn on one or both of the tester screens using the toggle switch above the screens.

Alarms

- When there is no fault, green light(s) are on
- When there is a heat wire fault, the heat wire light flashes red and an alarm will sound.
- When there is a ground wire fault, the ground wire light flashes red and the alarm wil sound.

Note: The alarm will sound for 2 seconds every 4 seconds in the first minute, then every 30 seconds to ensure battery conservation.

How

The Dual Cable Tester allows for two load-neutral-ground connections of cables of any voltage. It will measure resistance from 2 Ohms to 1000 Ohms with a 1% precision margin. Via a 9V battery it will send a continuous signal into the cable to monitor (1) a stable resistance between cores and (2) the absence of resistance on the ground sheath or cable.

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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 818.

2. Fast drying paint: Conform to Article M.07.21 of Form 818.

3. Glass beads: Conform to Article M.07.30 of Form 818.

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 818.

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.

B. Related Requirements

1. Sustainable Design Intent: Comply with project requirements intended to achieve sustainable credits, as indicated design, measured and documented according to LEED v4 BD+C construction prerequisites and credits, as indicated on the LEED v4 Matrix. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for mandatory and targeted strategies.

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. LEED Submittals:

1. One LEED Materials Reporting Form with each Product Data submittal, with supporting documentation:
    a. Environmental Product Declaration
    b. Recycled Content
    c. Health Product Declaration and/or Cradle to Cradle Certification
    d. UL Greenguard Gold Certification for paints, coatings, ceiling assemblies, wall assemblies, adhesives and sealants
    e. CRI Green Label Plus Certification for carpets and carpet padding
    f. SCS Floorscore Certification for flooring and subflooring
    g. UF/NAUF Certification for wood products
    h. FSC Chain of Custody certificate and invoices for all FSC wood products

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.

D. Delegated-Design Submittal: For structural performance of fence gate, foundation, and framework, including analysis data signed and sealed by the qualified professional engineer responsible for preparation.

E. 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. Post Caps: Colonial style.

E. Finish: All materials to be factory spray painted and cabinet dried in custom color with two coats of Sherwin-Williams vinyl safe paint and carrying a warranty of 25 years.

1. Color: Custom color to match RAL #7037 Semi Matte.

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 barrel hinges with grease fittings, 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 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design.

2.6 CONCRETE

A. Concrete: CTDOT Form 818, Article M.03.02, PCC03360.

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

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 – Metal Bench.
   2. Bicycle racks.
   3. Trash and recycle receptacles.
   4. Bollards – metal pipe with covers.
   5. 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.
   3. Sustainable Design Intent: Comply with project requirements intended to achieve sustainable credits, as indicated design, measured and documented according to LEED v4 BD+C construction prerequisites and credits, as indicated on the LEED v4 Matrix. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for mandatory and targeted strategies.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. One LEED Materials Reporting Form with each Product Data submittal, with supporting documentation:
      a. Environmental Product Declaration
      b. Recycled Content
      c. Health Product Declaration and/or Cradle to Cradle Certification
      d. UL Greenguard Gold Certification for paints, coatings, ceiling assemblies, wall assemblies, adhesives and sealants
      e. CRI Green Label Plus Certification for carpets and carpet padding
      f. SCS Floorscore Certification for flooring and subflooring
      g. UF/NAUF Certification for wood products
      h. FSC Chain of Custody certificate and invoices for all FSC wood products

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 – METAL BENCH

A. Basis-of-Design Product: Subject to compliance with the requirements, provide products indicated on the Drawings ”Multiplicity” Backed Bench by Landscape Forms, Inc., 431 Lawndale Avenue, Kalamazoo, MI 49048, (800) 521-2546.

B. “Multiplicity” Backed Bench:

1. Benches
   a. Style: Surface Mount style with end arms both ends.
   b. Depth: 23 inches.
   c. Overall Height: 2’-8 3/4” inches.
   d. Length: 7’-10 ½” inches.

C. Materials:

1. Seat and back panels: Exterior wood, thermally modified ash, no finish.
2. Frame, Legs, and Arms: Supports: Cast aluminum.

D. Accessories:
1. For anchoring in Concrete Pavements –
   a. 5/8-11 threaded bolt and 1/4-20x3/4” hex set screw for bench as provided by the Manufacturer.
   b. stainless steel drop-in anchors provided by the Contractor to work with threaded bolt above
   c. provide 4 sets per bench for surface mount.

2. For anchoring in Unit Paver Pavements –

a. 3/8-16 x 8-1/8” threaded rod (in lieu of the Manufacturer’s standard 3/8-16 x 5-1/8”).
b. epoxy anchors with minimum 4-1/2” embedment in concrete base in conformance with manufacturer’s installation instructions.
c. Provide 4 sets per bench for embed mount .

3. Provide stainless steel shims or washers to level benches before tightening anchors.

E. Fabrication: Shop assembled.

F. Finishes:

1. Finish on Metal: Landscape Forms, Inc. “Pangard II”.
   a. Primer: Rust inhibitor on ferrous supports.
   b. Topcoat: Thermosetting TGIC polyester powder coat. UV, chip, and flake resistant.
   c. Test Results: “Pangard II”.
      1) Gloss Consistency, Gardner 60 Degrees, ASTM D 523: Plus or minus 5 percent from standard.
      2) UV Resistance, Color and Gloss, ASTM G 155, Cycle 7: Delta E less than 2 at 2.0 mils and less than 20 percent loss.
      3) Cross-Hatch Adhesion, ASTM D 3359, Method B: 100 percent pass.
      4) Flexibility Test, Mandrel, ASTM D 522: 3 mm at 2 mils.
      5) Erichsen Cupping, ISO 1520: 8 mm.
      6) Impression Hardness, Buchholz, ISO 2815: 95.
      7) Impact Test, ASTM D 2794: 60 inch-pounds at 2.5 mils.
      8) Pencil Hardness, ASTM D 3363: 2H minimum.
      9) Corrosion Resistance, 1,500-Hour Test, ASTM B 117: Max. undercutting 1 mm.
      10) Humidity Resistance, 1,500-Hour Test, ASTM D 2247: Max. blisters 1 mm.
2. Color: Custom color to match RAL #7037 Semi Matte.

2.2 BICYCLE RACKS

A. Basis of Design Standard: “Ride” bicycle rack as manufactured by Landscape Forms, Inc., 431 Lawndale Avenue, Kalamazoo, MI 49048. 800 521-2546 www.landscapeforms.com. Subject to compliance with requirements, provide the named product, or comparable product of Model SCBR1600 Series as manufactured by Maglin Site Furniture, (800) 716-5506 www.maglin.com or Model EP 5950 Ipe as manufactured by Equiparc, (800) 363-9264 www.equipaqrc.com.

B. “Ride” Bicycle Rack
1. Material:
   a. Frame: Aluminum Casting – 319 ASTM B26 or 356 ASTM B108 & LFI 7.4.2-A1.
2. Embedded Mount:
   a. Embedded Hardware Pack: Steel rod, 5/8-11 X 3 1/2" threaded rod with magni 565 – silver top coat, with thread patch..
3. Finishes:
   a. Primer: Rust inhibitor

b. Topcoat: Thermosetting TGIC polyester powder coat. UV, chip and flake resistant.
c. Test Results: Pangard II
   1) Gloss consistency, Gardner 60 Degrees, ASTM D 523: Plus or minus 5 percent from standard.
   2) UV Resistance, Color and Bloss, ASTM G 155, Cycle 7: Delta E less than 2 at 2.0 mils and less than 20 percent loss.
   3) Cross-Hatch Adhesion, ASTM D 3359, Method B: 100 perecnt pass.
   4) Flexibility Test, Mandrel, ASTM D 522: 3mm at 2 mils.
   5) Erichsen Cupping, ISO 1520: 8mm.
   6) Impression Hardness, Buchholz, ISO 2815: 95.
   7) Impact Test, ASTM D 2794: 60 inch-pounds at 2.5 mils.
   8) Pencil Hardness, ASTM D 3363: 2H minimum.
   9) Corrosion Resistance, 1,500-Hour Test, ASTM B 117: Max undercutting 1 mm.
   10) Humidity Resistance, 1,500-Hour Test, ASTM D 2247: Max blisters 1 mm.
d. Color: Custom color to match RAL #7037 Semi Matte.

2.3 TRASH AND RECYCLE RECEPTACLES

A. Basis-of-Design Product: Subject to compliance with the requirements, provide products indicated on the Drawings, "Chase Park" litter receptacle by Landscape Forms, Inc., 431 Lawndale Avenue, Kalamazoo, Michigan 49048. Toll Free (800) 521-2546. Phone (269) 381-0396. Fax (269) 381-3455

B. "Chase Park" Litter Receptacles
   1. Style:
      a. Top-Opening Style
         1) Top opening, 5-inch diameter for Recycle
         2) Top opening, 10-inch diameter for trash
   2. Mounting:
      a. Surface mounted
   3. Signage:
      a. For top-opening recycling litter: To be selected by the Architect.
      b. For top-opening trash litter: To be selected by the Architect.

C. MATERIALS
   1. Base: Rotationally molded linear low density polyethylene. Color is dark gray. Base is filled with concrete for stability.
   2. Sides and Door: Cast 319 aluminum.
   3. Hinges: Two, carbon steel with silver Magni-coat, connects sides and door.
   4. Latch: carbon steel with silver Magni-coat
   5. Lock Cam, and Lock Plate: Type 304 Stainless steel.
   6. Lid: 0.100-inch thickness, spun 1100-0 aluminum.
   7. Lid Bracket: 1-inch by 1-inch by 1/4-inch aluminum angle.
   8. Liners: Black, formed polyethylene.
   9. Single liner, top opening litter, 40 gallon capacity
   10. Fasteners: Stainless steel.
   11. Security Cable: 1/16-inch diameter, 24-inch long, nylon-coated stainless steel wire rope with eye fittings.

12. Recycling sign backer plates: Two 8-inch wide by 6-inch tall by 1/8-inch thick, 3003 or 5052 aluminum plates welded to back panel and door.
13. Recycling sign decals: Two 5-inch tall by 7-inch long, exterior-grade vinyl.

D. ACCESSORIES
1. Anchor Bolts: Stainless Steel, provided by the installer.

E. RECYCLED CONTENT
1. Post-Consumer Material Content: Minimum 10 percent.
2. Pre-Consumer Material Content: Minimum 48 percent.
3. Recyclable: 100 percent.

F. FABRICATION
1. Shop assembled litter receptacles.

G. FINISHES
1. Finish on Metal: Landscape Forms, Inc. “Pangard II”.
   a. Primer: Rust inhibitor.
   b. Topcoat: Thermosetting polyester powdercoat. UV, chip, and flake resistant.
   c. Test Results: “Pangard II”.
   d. Gloss Consistency, Gardner 60 Degrees, ASTM D 523: Plus or minus 5 percent from standard.
   e. UV Resistance, Color and Gloss, ASTM G 155, Cycle 7: Delta E less than 2 at 2.0 mils and less than 20 percent loss.
   f. Cross-Hatch Adhesion, ASTM D 3359, Method B: 100 percent pass.
   g. Flexibility Test, Mandrel, ASTM D 522: 3 mm at 2 mils.
   h. Erichsen Cupping, ISO 1520: 8 mm.
   i. Impression Hardness, Buchholz, ISO 2815: 95.
   j. Impact Test, ASTM D 2794: 60 inch-pounds at 2.5 mils.
   k. Pencil Hardness, ASTM D 3363: 2H minimum.
   l. Corrosion Resistance, 1,500-Hour Test, ASTM B 117: Max undercutting 1 mm.
   m. Humidity Resistance, 1,500-Hour Test, ASTM D 2247: Max blisters 1 mm.
2. Color: Custom color to match RAL #7037 Semi Matte.

2.4 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.

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: custom color to match RAL #7037 Semi Matte.
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’.

2.5 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, BICYCLE RACK AND TRASH/RECYCLE RECEPTACLE 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 323400 – PREFABRICATED PEDESTRIAN BRIDGE

SPECIAL PROVISIONS FOR PREFABRICATED HALF THROUGH TRUSS CONTINENTAL® PEDESTRIAN BRIDGE

1.0 GENERAL

1.1 Scope

These specifications are for fully engineered half through truss (no overhead bracing) bridge of steel construction and shall be regarded as minimum standards for design and fabrication. The work included under this item shall consist of design, fabricating, finishing and transporting the steel truss bridge superstructure including bearings. These specifications are based on products designed and manufactured by Contech Engineered Solutions LLC.

1.2 Definitions

- *Owner*: Entity who ultimately will own the bridge.
- *Engineer*: Engineering Entity or Firm who will be representing the Owner.
- *Contractor*: Entity who will be installing, and/or purchasing, the bridge.
- *Foundation Engineer*. Engineering Entity or Firm who will be designing and detailing the foundation system.
- *Geotechnical Engineer*. Engineering Entity or Firm who will be responsible for providing the Geotechnical information necessary to design the foundation system.
- *Bridge Manufacturer*: Firm who will be designing and supplying the bridge in accordance with these Special Provisions.

1.3 Related Documents

A. Sustainable Design Intent: Comply with project requirements intended to achieve sustainable design, measured and documented according to LEED v4 BD+C construction prerequisites and credits, as indicated on the LEED v4 Matrix. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for mandatory and targeted strategies.

1.4 Qualified Bridge Manufacturer

Each Contractor is required to identify their intended supplier as part of the bid submittal. Qualified Bridge Manufacturers must have at least 5 years of experience fabricating these types of structures and shall have an up to date quality certification by AISC per Section 14.1 of these specifications. All suppliers shall fabricate their product utilizing a modern fabrication facility owned and operated by the Bridge Manufacturer that includes the use of CNC beam drilling machines, no brokers are allowed.

Pre-Approved Bridge Manufacturer:

Contech Engineered Solutions LLC
1-800-338-1122
E-mail: info@conteches.com

Bridge Manufacturers, other than those listed above, may be used provided the Engineer receives a written request at least 10 days prior to the bid. The written request shall accompany the following information:

- Bridge Manufacturer's Product Literature,
- Name and resume of Bridge Manufacturer's design professional who will be signing and sealing the engineering submittals,
- Copy of current AISC certification,
- Representative copies of detailed drawings, field procedures, calculations, quality control manual, welder's certifications, proof of in-house C.W.I.,
- Listing of projects including owner, location, size, year of fabrication, contact person,
- Certification by the Bridge Manufacturer's Design Professional that the bridge proposed will be in accordance with all project development done up to the date of these specifications.

The above will be evaluated by the Engineer for accuracy and ability to provide the bridge in accordance with these specifications. Bridge Manufacturers other than those listed above may only be used if the Engineer provides written approval via addendum 5 days prior to the bid. The Engineer's ruling shall be final.

1.5 Bridge Manufacturer's Design Professional and Action Submittals

A. Engineer

The Bridge Manufacturer shall have as a direct employee, an engineer who is experienced in bridge design to be in responsible charge of all engineering related task and design. The engineer shall have a minimum of 10 years of experience in bridge design and be a currently licensed civil or structural engineer in the State of Connecticut and shall be the engineer who will seal and sign the plans.

B. Shop Drawings

C. Engineering drawings, 11x17 format, shall be prepared and submitted to the Contractor or Owner for their review after receipt of the order. Submittal drawings shall be unique drawings, prepared to illustrate the specific portion of the bridge being fabricated. All relative design information such as member size, ASTM/AASHTO material specification, dimensions necessary to fabricate and required welding shall be clearly shown on the drawings. Drawings shall have referenced details and sheet numbers. All drawings shall be stamped, signed and dated by the Bridge Manufacturer's Design Professional.

D. Structural Calculations

Structural calculations for the design of the bridge superstructure shall be prepared by the Bridge Manufacturer and submitted for review after receipt of the order. Calculations shall include complete design, analysis and code checks for the controlling members, connectivity and support conditions, truss stability checks, deck design, deflection checks, bearings and all splices.

E. LEED Submittals:

1. One LEED Materials Reporting Form with each Product Data submittal, with supporting documentation:
   a. Environmental Product Declaration.
   b. Recycled Content.
   c. Health Product Declaration and/or Cradle to Cradle Certification.
   d. UL Greenguard Gold Certification for bridge assemblies and adhesives.

2.0 APPLICABLE CODES AND STANDARDS

2.1 Governing Specifications

Bridge shall be designed in compliance with the AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges, 2009 (*AASHTO Ped*). Calculations shall be in accordance with this document, and formulas shall reference the appropriate sections.

2.2 Other Reference Codes, Specifications and Standards

- AASHTO LRFD Bridge Design Specifications, 9th Edition, 2020 (*AASHTO LRFD*)
- AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, First Edition, 2005 (*AASHTO Signs*)
- AISC Steel Construction Manual, 15th Edition, 2017 (*AISC*)
- ANSI/AISC 360-16 Specification for Structural Steel Buildings, 2016 *(AISC 360)*
- American Welding Society, Structural Welding Code, D1.1, 2015 (*AWS D1.1*)
- ASCE/SEI 7-10 Minimum Design Loads for Buildings and Other Structures, 2010 (*ASCE 7*)
- Setra Technical Guide for Footbridges, 2006 (Setra)
- ANSI/AWC NDC-2015 National Design Specification for Wood Construction, 2015 (*NDS*)
- Tropical Timbers of the World, US Forest Products Laboratory

The AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges shall control if any conflicting requirements occur with the Other Reference Documents and/or other local Codes.

3.0 BRIDGE SYSTEM TYPE

3.1 Truss Style

The truss style shall be a Connector®. The vertical trusses shall be designed such that the top and bottom chord members are parallel for the entire length of bridge. The interior verticals of the trusses shall be perpendicular to the top face of the bottom chord and the end verticals of the trusses shall be plumb. Trusses shall be laid out such that diagonals shall be at an angle of 30-degrees or more with respect to the bottom chord.

3.2 Diagonal Style

The vertical truss shall use a single-diagonal, Pratt configuration, where all the diagonals are in tension for gravity loads.

3.3 Floor Beam Location

The bridge shall utilize an H-Section configuration where the ends of the floor beams are welded only to the interior face of the verticals. The distance from the top of deck to the bottom of the bottom chord shall be determined by the Bridge Manufacturer during final design.

4.0 BRIDGE GEOMETRY

4.1 Span Length

The bridge span lengths shall be 25’-5” and 116’-8” (horizontal straight line dimension) and measured from end to end of the bridge truss, not including the end dam, any deck extension or bearing that extends beyond the end of the truss.

4.2 Width

The bridge width shall be 6‘-0” and shall be as measured from the inside face of structural truss elements at the deck level.

4.3 Top of Truss Height Above Deck

The top of the top chord shall not be less than 48" above the deck (measured from the high point of the deck). Note that this dimension may be exceeded due to truss height requirements for structural, deflection and vibration requirements.

4.4 Lower Steel Clearance

The maximum distance from the top of the deck (measured from the highest point of the deck) to the bottom of any steel member shall be 2’-0”.

4.5 Truss Bay Spacing

The number of bays and the dimension of the panel points shall be determined by the Bridge Manufacturer.

4.6 Camber

A single simple-span bridge shall have a vertical camber dimension at the mid span equal to 100% of the anticipated full dead load deflection rounded up to the next ¼".

4.7 Elevation Difference

The top of the decks at each end of the bridge shall be constructed with a vertical elevation difference to produce a 4.62% grade slope along the bridge deck.

5.0 STRUCTURAL DESIGN LOADS

5.1 Dead Load

The bridge structure shall be designed for the total bridge weight including the final deck system.

5.2 Pedestrian Loading (PL)

The bridge structure shall be designed for a uniform pedestrian loading of 90 psf. This loading shall be patterned to produce the maximum load effects. Consideration of dynamic load allowance is not required with this loading.

5.3 Vehicle Load (VL)

When vehicular access is prevented by permanent physical methods, the floor system shall be designed for each of the following concentrated/vehicular loads:

- A concentrated load of 1,000 pounds placed on any area 2.5 ft by 2.5 ft square.
- A 1,200 pound two-wheel vehicle with a wheelbase of 60", with the load equally distributed to two axles with a tire footprint of 1.5" in the direction of traffic and 4" transverse to the direction of traffic.

5.4 Wind Load (WS)

Pedestrian bridges shall be designed for wind loads as specified in *AASHTO Signs*, Articles 3.8 and 3.9. The loading shall be applied over the exposed area in front elevations of both trusses including all enclosures.

In addition to the wind load specified above, a vertical uplift line load as specified in *AASHTO LRFD* Article 3.8.2 and determined as the force caused by a pressure of 20 psf over the full deck width, shall be applied concurrently. This loading shall be applied at the windward quarter point of the deck width.

5.5 Seismic (EQ)

The bridge structure shall be designed for seismic loading as specified in Section 3.10 of *AASHTO LRFD*. The transverse loads shall be calculated considering the transverse period of the bridge and longitudinal loads shall be calculated using a period of zero. A

response modification factor of 0.8 shall be used for the calculation of forces applied to the bridge anchorage. A response modification factor of 1.0 shall be used for the calculation of bearing reactions. The transverse seismic load shall be applied to all the bearings and the longitudinal seismic load shall be applied to the fixed bearings only. The vertical bearing reactions shall be calculated using an overturning force on the bridge based on the center of gravity of the bridge times the transverse seismic load.

5.6 Fatigue Load (FL)

The fatigue loading shall be as specified in Section 11 of *AASHTO Signs*. The Natural Wind Gust specified in Article 11.7.1.2 and the Truck-Induced Gust specified in Article 11.7.1.3 of *AASHTO Signs* only need only be considered, as appropriate.

5.7 Combination of Loads

The load combinations and load factors to be used shall be as specified in *AASHTO LRFD* Table 3.4.1-1, with the following exceptions:

- Load combinations Strength II, Strength IV, and Strength V need not be considered.
- The load factor for Fatigue I load combination shall be taken as 1.0, and Fatigue II load combination need not be considered.

6.0 STRUCTURAL DESIGN CRITERIA

6.1 Modeling

The bridge shall be modeled and analyzed utilizing a three-dimensional computer software which shall account for moments induced in members due to joint fixity where applicable. Moments due to both truss deflection and joint eccentricity must be considered. All loads listed in Section 5 of these specifications shall be applied to the model and analyzed appropriately.

6.2 Lateral Frame and Member Design

The bridge shall be designed and proportioned such that appropriate lateral stiffness is provided locally and globally, to ensure that the structure is stable.

For bridges without any overhead members (Half-Through Trusses), the vertical truss members, the floor beams and their connections shall be proportioned to resist a lateral force applied at the top of the truss verticals at the center of the top chord. This lateral force shall be applied as an additional load to the top of the vertical at the center of the top chord, creating a cantilever moment, which is then added to the forces obtained from the three-dimensional model. The magnitude of this lateral force shall not be less than 0.01/K times the average factored design compressive force in the two adjacent top chord members increased by a factor of safety of 1.33.

The top chord shall be analyzed as a column with elastic lateral supports at the panel points, considering all moments due to in-plane and out-of-plane bending, along with moments due to eccentricities of the members.

The U-Frame Stiffness of the verticals and floor beams shall be as specified in *AASHTO Ped* Article 7.1.2, assuming that the vertical and floor beam connection is rigid. This means that the following must be met:

- On H-Section floor beam connections, the floor beam width shall be at least 80% of the vertical face width in order to prevent any deformation due to tube wall plastification of the vertical member faces under service loads. The connection design will be checked at Strength I & Strength III load combinations.
- On Underhung floor beam connections, the vertical width shall match the bottom chord width in order to transfer vertical moments through the walls of the bottom chord to the verticals with no deformation of the chord side walls due to sidewall yielding or crippling under service loads. The connection design will be checked at Strength I & Strength III load combinations.
- The vertical and floor beam members shall not be connected to faces of the bottom chord at a 90-degrees to one another.
- All fixed end moments in the floor beams and verticals due to floor beam rotations, in addition to the loads derived from a U-Frame analysis have been accounted for in the strength design of the connections.

The vertical and floor beam members shall be proportioned such that the effective length factor, K, used in the design of the top chord shall not be greater than 2.0.

The end verticals shall be designed as a simple cantilever to carry the loads obtained from the three-dimensional model, plus the cantilever moment due to a lateral load of 0.01 times the axial force in the end vertical, applied laterally at the top end of the end vertical at the center of the top chord.

The floor beams shall be sized for the forces obtained from a simple span, pinned end analysis, or from the forces obtained from the three-dimensional model, whichever controls.

The diagonals and brace diagonals shall be analyzed as pinned-end connection members.

Interior verticals shall be analyzed as pinned-end connections unless longitudinal forces are applied to the verticals such as when the brace diagonals are connected to floor beams on an H-Section floor beam configuration. When longitudinal forces are applied to the verticals they shall be analyzed as fixed-end connections.

All other members shall be analyzed as fixed-end connections.

HSS member connections shall be evaluated per the requirements of *AISC 360* Chapters J & K.

6.3 Deflections

The vertical deflection of the bridge due to the unfactored pedestrian live loading shall not exceed 1/360 of the span length.

The horizontal deflection of the bridge under unfactored wind loading shall not exceed 1/360 of the span length.

6.4 Fracture

The fracture toughness requirements and designation of Fracture Critical Member and Main Member designation are hereby waived for these structures.

6.5 Vibrations

Vibration of the structure shall not cause discomfort or concern to the users of the bridges. To assure this, the fundamental frequency (f) of the pedestrian bridge in the vertical direction, without live load, shall be greater than 3.0 hertz (Hz) to avoid the first harmonic. The fundamental frequency of the pedestrian bridge in the lateral direction, shall be greater than 1.3 Hz. If the fundamental frequency cannot satisfy these limitations, then the bridge should be proportioned such that either of the following criteria are satisfied:

$$f \geq 2.86 * \ln(180/W)$$

or

$$W \geq 180 * e^{(-0.35 * f)}$$

Where W is the weight of the bridge in kips and f is the fundamental frequency in the vertical direction in Hz.

For bridges longer than 85 ft and shorter than 125 ft the vertical and horizontal vibration must also meet the requirements for Bridge Class III with a Mean comfort level in accordance with *Setra*.

7.0 DECK SYSTEM

7.1 Deck System

Deck to be comprised of transverse wood planks attached to longitudinal steel stringers that are attached to the floor beams.

The wood deck timber planks shall be Ipe wood (Tabebuia spp. -lapacho group), FEQ grade, all heartwood (no sapwood), clear (no knots), straight grained, with no worm holes, surfaced 4 sides (S4S) and eased at four edges (E4E), and be air dried to no more than 20% moisture content prior to installation. Planks shall be untreated, except ends of planks shall be sealed with “Anchorseal” as manufactured by Mobil CER-M or an equal aqueous wax log sealer. Based on the Forest Products Laboratory value of 27,270 psi for Modulus of Rupture, Modulus of Elasticity of 3,030,000 psi and Maximum Crush Strength of 13,720 psi the following allowable stresses shall apply. Allowable bending stress without modification factors of 3,700 psi; allowable shear without modification factors of 320 psi.

Deck planks shall be secured utilizing 5/16” flat head self-tapping screws. Each plank shall have enough screws to adequately secure the plank to the stringers and prevent cupping and twisting of the board. Screws shall have adequate edge distance to prevent splitting and cracking. The end edges of the deck planks shall include a cover plate or angle to hide the plank ends from the bridge user or be precision end cut such that the ends are all within 1/16” from plank to plank. Deck planks shall be placed tight together with no gaps.

Deck planks shall be sized to support the loads specified in Section 5.0 of these specifications.

Each deck plank shall be designed to support the maximum wheel load from the design vehicle. Distribution to other planks will only be allowed if those planks are doweled together or if the tire contact wheel length is longer than the width of the plank. The Tire Contact Area will be calculated as 0.01 times the wheel load. The wheel width transverse to the direction of traffic, is 2.5 times the wheel length. The wheel width is calculated as follows:

- The Wheel Width (in inches) is $2.5 * \sqrt{(\frac{0.01*P}{2.5})}$, where P is the wheel load in pounds.

Plank shall be checked for both shear and moment, and meet all allowable stresses as per *Tropical Timbers of the World*.

8.0 MATERIALS OF CONSTRUCTION

8.1 Structural Steel

All members of the truss and deck support system shall be fabricated from square or rectangular hollow structural shapes (HSS), with the exception that floor beams may be wide flange shapes. All open ends of end posts and floor support beams shall be capped. Drain holes shall be provided for all sections at the low point of the member that may become filled with water.

All bridges shall be fabricated using A500 Grade C for HSS sections, A992 for structural shapes and A572 for plates.

Minimum nominal thickness of primary hollow structural shapes shall be 1/4". Rolled shapes shall have a minimum thickness of 1/4".

8.2 Fasteners

Structural bolts used to field splice or connect all main members shall be ASTM F3125 Grade A325. The nuts for these structural bolts shall be ASTM A563. The Bridge Manufacturer shall determine the finish of the structural bolts. They will be either Type 3 (Weathering) or Type 1 (Hot-Dipped or Mechanically Galvanized) as specified by the Bridge Manufacturer.

Bolts used for the connection of a wood rub rail shall be 18-8 or 316 Stainless Steel, ¼” diameter carriage bolts.

Screws for the attachment of wood deck shall be steel, 5/16” diameter, six lobe drive, self-tapping screws. The screws shall have flat heads for the screws in the wood and round heads for the screws on the edge cover. The screws shall have a protective coating that will prevent corrosion due to contact with treated wood and environmental exposure.

Self-drilling fasteners for attachment of the form decking shall be #14 x 1” zinc plated hex washer head Tek screws.

Power Actuated fasteners shall be Hilti sheet metal nail X-ENP-19 fastener.

Other miscellaneous fasteners shall be ASTM A307 zinc plated or galvanized, as determined by the Bridge Manufacturer.

9.0 FINISH

Painted structures require special fabrication details to ensure that all exposed surfaces receive the proper surface preparation and correct amount of paint. When overlapping steel surfaces occur, a space of 1.5” or greater must be maintained. If this space cannot be maintained, then steel spacers shall be inserted to eliminate the space. All overlapping steel surfaces with a space less than 1.5” shall be seal welded all around to prevent access by water. Caulking of overlapping surfaces shall not be allowed.

After fabrication, all structural steel shall be hot-dipped galvanized in accordance with ASTM A123. Prior to galvanizing all surfaces of structural steel to be cleaned in accordance with Steel Structures Painting Council Surface Preparation Specifications No.1, SSPC-SP1 solvent cleaning. All closed members shall have drain and or vent holes as necessary to accommodate the galvanizing process. All holes will be drilled or CNC plasma cut, no torched holes will be allowed. All holes to be pluged with zinc or aluminum plugs after galvanizing.

After galvanizing and prior to painting, all surfaces to be painted shall be cleaned in accordance with Steel Structures Painting Council (SSPC), Surface Preparation Specification No. 16, latest edition, (SSPC-SP16), Brush Off Blast Cleaning of Coated and Uncoated Galvanized Steel.

Two-coat paint system shall be a primer coat of Macropoxy 646 Fast Cure Epoxy Primer by Sherwin Williams, 5.0-10.0 mils DFT, and a finish coat of Acrolon 218 HS Acrylic Polyurethane Semi-Gloss by Sherwin Williams, 3.0-6.0 mils DFT, color to be selected by Owner.

10.0 ATTACHMENTS

10.1 Safety Rails

Safety rail system shall be placed on the inside of the structure, spaced so as to prevent a 4" sphere from passing through the side truss for the full height of the side truss, or 42" , whichever is less. The top of the top chord may be considered the top of the rail system.

Rails system shall consist of horizontal rails. Rails shall be HSS 1 x 1 x 1/8 welded to truss verticals and a maximum unsupported length of 7’-0” if placed on the inside of the structure and 8’-0” if placed on the outside of the structure. If the truss vertical spacing is

greater than the maximum unsupported length, mid-bay supports will be required. When safety rails are placed on the inside of the structure and not covered by the end vertical, the ends of rail near the end of the bridge shall be capped and ground smooth. No solid plate covering all rails as a unit will be allowed.

Each element of the pedestrian rail system shall be designed to support a uniformly applied load of 50 pounds per lineal foot, both transversely and vertically, acting simultaneously. In addition, each longitudinal element shall be designed to support a concentrated load of 200 pounds, which will act simultaneously with the above uniform loads at any point and in any direction at the top of the longitudinal element.

The posts of the pedestrian rail system shall be designed for a concentrated load applied at either the center of gravity of the upper longitudinal element or 60" above the top of the walkway, whichever is less. This concentrated load shall be equal to 200 pounds plus 0.05 times the post spacing in feet.

10.2 Toe Plate

Toe Plates shall be HSS4x2x3/16 tube welded all around to the inside face of the truss verticals. The maximum unsupported length shall be 12’-0”. When the ends of the toe plates near the end of the bridge are not covered by the end verticals, they shall be capped and ground smooth. The bottom of the toe plate shall be placed 2” above the finished height of the deck. All seams of the toe plates shall be fully welded to give the appearance of a continuous member (welding should be located at a support member). If toe plates are incorporated into a safety rail system, they may be modified as needed but shall be a minimum of 4” high.

10.3 Expansion Joint

The gap between the end of the bridge deck and the back wall of the foundation system be sized to accommodate bridge movements due to thermal expansion of the bridge over the design temperature range. The gaps shall be covered with a steel cover which attaches to the bridge and extends over the gap and onto the top of the foundation system back wall. The steel cover shall have its edges rounded or beveled at a 45-degree angle. A compression seal sized for movement and rated for pedestrian traffic may be used in place of the steel cover.

11.0 BEARINGS

11.1 Bearing Type

Bearing type and size shall be designed by the Bridge Manufacturer based on anticipated loads and movements.

11.2 Design Temperature Range

The Design Temperature Range will be site specific and will be determined per *AASHTO LRFD* Article 3.12.2.

11.3 Non-Shrink Grouting

The bridge will be supplied with a lower setting plate. This setting plate shall be leveled and shimmed to the proper elevation. The space between the lower surface of the setting plate and the foundation surface shall be filled with a non-shrink grout capable of achieving a minimum compressive strength equal to or greater than the strength of the foundation concrete. The cost of the leveling, shimming, and non-shrink grout shall be the responsibility of the Contractor.

12.0 FOUNDATIONS

12.1 Foundation System

Foundation system shall utilize abutments designed by the Foundation Engineer in conjunction with the bridge bearing requirements and dimensions provided by the Bridge Manufacturer and the site-specific geotechnical information provided by the Geotechnical Engineer. All abutment dimensions and materials shall be shown on the final contract plans.

12.2 Anchor Bolts

Bridge Manufacturer shall design the diameter and grade of anchor bolts, based on the shear and tensile strength of the anchor bolt material only. All design considerations regarding concrete breakout strength in shear and tension, pullout strength, concrete side-face blowout strength, concrete pry out strength, embedment depth, type of anchorage or any other concrete failure modes are the responsibility of the Foundation Engineer and shall be shown on the final contract plans. All anchor bolts shall be galvanized. The Foundation Engineer shall determine if the anchor bolts shall be cast-in-place, drilled/epoxy, or expansion anchors. Anchor bolts shall be provided and installed by the Contractor.

13.0 FABRICATION

13.1 Welding

Welding procedures and weld qualification test procedures shall conform to the provisions of *AWS D1.1*. Filler metal shall be in accordance with the applicable AWS Filler Metal Specification and shall match the corrosion properties of the base metal.

13.2 Welders

Welders shall be qualified for each process and position used while fabricating the bridge. Qualification tests shall be in accordance with AWS D1.1. All weld qualifications and records shall be kept in accordance with the Fabricator’s Quality Assurance Manual which has been approved and audited by AISC as the basis for certification.

13.3 Shop Splices

Shop splices for main truss members shall be full penetration welds all around the

perimeter of the member. These shop splices shall be performed using a full perimeter backing plate. After welding of the shop splices, the weld shall be ground smooth to match the perimeter of the member. Grinding these welds smooth is required and will be grounds for rejection of the bridge upon delivery if not completed.

Shop splices for all horizontal rail components to be located at the centerline of the truss verticals, each end welded to the truss vertical and seal welded together. Exposed surface of the seal welds as seen from the deck shall be ground smooth.

Shop spliced for all horizontal stringers to be located at the centerline of the floor beams, each end welded to the floor beam and seal welded together.

13.4 Bolted Splices

For shipping purposes, the bridge may be fabricated in sections. Sections shall be field assembled using bolted connections. No field welding of members shall be allowed.

The chord members of the bridge shall be bolted such that at least two faces of the member are bolted. This is to provide reasonable force distribution around the perimeter of the member. Bolted splices shall be designed and fabricated such that the head of the bolt and washer are the only item exposed. No through-bolting of the member is allowed. The nuts of the fastener cannot be welded to the internal splice plate and shall be held in plate with a nut capture system per Patent US 10,267,345 B2 or equal.

The diagonals and brace diagonals shall be bolted utilizing a through-bolt system with plates on the exterior faces of the members. An internal stiffening plate is required to keep the member from crushing during the bolt tightening process.

All bolted connections are considered to be pretensioned or slip-critical connections. All bolts are to be pretensioned per the requirements of section 8.2 of the Specification for Structural Joints Using High-Strength Bolts. Recommended tightening method of all structural bolts shall be Turn-of-the-Nut Pretensioning.

14.0 QUALITY CONTROL

14.1 AISC Certification

The bridge shall be fabricated in a shop owned by the Bridge Manufacturer. This facility shall have up to date quality certification by AISC as Certified Bridge Fabricator - Advanced (Major) with Fracture Critical Endorsement and Sophisticated Paint Endorsement.

14.2 Certified Weld Inspector

The Bridge Manufacturer shall employ a Certified Weld Inspector (CWI), with endorsement by AWS QC1. This CWI shall be present during the complete fabrication of the bridge. The CWI shall provide written documentation that the bridge has been fabricated in accordance with these specifications and the approved design drawings.

14.3 Documentation

Material Certifications shall be available for review for all materials within the bridge. Traceability of heat numbers is required for all structural steel.

Documentation showing the performance of all critical quality checks shall also be made available for review by the Engineer or Owner.

14.4 Non-Destructive Testing

All welds within the structure, shall be visually inspected for conformance to size, under cut, profile and finish.

All shop splices of main truss members shall be magnetic particle tested.

15.0 DELIVERY AND ERECTION

15.1 Delivery

Delivery shall be made via truck to a location nearest the site which is accessible to normal over-the-road equipment. All trucks delivering bridge materials will need to be unloaded at the time of arrival. If the erection Contractor needs special delivery or delivery is restricted, they shall notify the Bridge Manufacturer prior to bid date. This includes site issues which may prevent over-the-road equipment from accessing the site. Steerable dollies are not used in the cost provided by the Bridge Manufacturer. Determining the length of bridge section which can be delivered is the responsibility of the Contractor and shall be communicated to the Bridge Manufacturer prior to the bid date.

15.2 Installation & Lifting Procedures.

The Bridge Manufacturer will provide standard typical written procedures for lifting and splicing the bridge. All actual means, methods, equipment and sequence of erection used are the responsibility of the Contractor.

16.0 WARRANTY

The Bridge Manufacturer shall warrant, at the time of delivery, that it has conveyed good title to its steel structure, free of liens and encumbrances created by the Bridge Manufacturer, and that its steel structure is free of defects in design, material and workmanship. This warranty shall be valid for a period of one (1) year from the earlier date of delivery or 60 days after final fabrication is complete. Durable tropical hardwood decking and hardwood attachments shall carry a one (1) year warranty against rot, termite damage, or fungal decay. This warranty shall specifically exclude all softwood and decking material such as Treated Southern Yellow Pine, Douglas Fir and Wood thermoplastic composite lumber (e.g. Trex). Paint, galvanizing and other special coatings, if warranted, shall be warranted by the coating manufacturer in accordance with their warranty provisions and are not covered under the Bridge Manufacturer’s warranty.

This warranty shall not cover defects in the steel structure caused by abuse, misuse, overloading, accident, improper installation, maintenance, alteration, or any other cause not expressly warranted. This warranty shall not cover damage resulting from or relating to the use of any kind of de-icing material. This warranty shall be void unless owner's records are supplied that show compliance with the minimum guidelines specified in the in the Bridge Manufacturer’s inspection and maintenance procedures.

Repair, replacement, or adjustment, in Bridge Manufacturer’s sole discretion, shall be the exclusive remedy for any defects under this warranty. This warranty shall exclude liability for any indirect, consequential, or incidental damages.

END OF SECTION 323400

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.
   4. Sustainable Design Intent: Comply with project requirements intended to achieve sustainable credits, as indicated design, measured and documented according to LEED v4 BD+C construction prerequisites and credits, as indicated on the LEED v4 Matrix. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for mandatory and targeted strategies.

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. LEED Submittals:

1. One LEED Materials Reporting Form with each Product Data submittal, with supporting documentation:
    a. Environmental Product Declaration
    b. Recycled Content
    c. Health Product Declaration and/or Cradle to Cradle Certification
    d. UL Greenguard Gold Certification for paints, coatings, ceiling assemblies, wall assemblies, adhesives and sealants
    e. CRI Green Label Plus Certification for carpets and carpet padding
    f. SCS Floorscore Certification for flooring and subflooring
    g. UF/NAUF Certification for wood products
    h. FSC Chain of Custody certificate and invoices for all FSC wood products

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, New England Erosion Control/Restoration mix 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.
2. Sustainable Design Intent: Comply with project requirements intended to achieve sustainable credits, as indicated design, measured and documented according to LEED v4 BD+C construction prerequisites and credits, as indicated on the LEED v4 Matrix. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for mandatory and targeted strategies.

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.

B. LEED Submittals:
   1. One LEED Materials Reporting Form with each Product Data submittal, with supporting documentation:
      a. Environmental Product Declaration
      b. Recycled Content
      c. Health Product Declaration and/or Cradle to Cradle Certification
      d. UL Greenguard Gold Certification for paints, coatings, ceiling assemblies, wall assemblies, adhesives and sealants
      e. CRI Green Label Plus Certification for carpets and carpet padding
      f. SCS Floorscore Certification for flooring and subflooring
      g. UF/NAUF Certification for wood products
      h. FSC Chain of Custody certificate and invoices for all FSC wood products

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 Erosion Control/Restoration and 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 Erosion Control/Restoration Mix:
1. Basis-of-Design Product: Subject to requirements, provide "New England Erosion Control/Restoration 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.

F. 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 EROSION CONTROL/RESTORATION 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, EROSION CONTROL/RESTORATION MIX AND CONSERVATIONS/WILDLIFE SEED MIX

3.10 MAINTENANCE

A. Maintain and establish wetmix, erosion control/restoration mix 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, ersosion control/restoration 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, Erosion Control/Restoration Mix and Conservation/Wildlife Mix Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Wetmix, Erosion Control/Restoration Mix 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.
3. Sustainable Design Intent: Comply with project requirements intended to achieve sustainable credits, as indicated design, measured and documented according to LEED v4 BD+C construction prerequisites and credits, as indicated on the LEED v4 Matrix. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for mandatory and targeted strategies.

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.

D. LEED Submittals:
1. One LEED Materials Reporting Form with each Product Data submittal, with supporting documentation:
    a. Environmental Product Declaration
    b. Recycled Content
    c. Health Product Declaration and/or Cradle to Cradle Certification
    d. UL Greenguard Gold Certification for paints, coatings, ceiling assemblies, wall assemblies, adhesives and sealants
    e. CRI Green Label Plus Certification for carpets and carpet padding
    f. SCS Floorscore Certification for flooring and subflooring
    g. UF/NAUF Certification for wood products
    h. FSC Chain of Custody certificate and invoices for all FSC wood products

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 EDGE RESTRAINTS

A. Aluminum Edge Restraints: Manufacturer's standard extruded-aluminum edging 3/16 inch thick by 5-1/2 inches high with loops pressed from face to receive stakes at 12 inches o.c., and aluminum stakes 12 inches long for each loop.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    a. Curv-Rite Inc.
    b. Permaloc Corporation.
    c. Sure-loc Edging Corporation.

B. Finish: Aluminum edge restraint and stakes to be mill finish by the manufacturer.

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