



DLR Group

Architecture

Engineering

Planning

Interiors

Lee's Summit Middle School #4

Lee's Summit R-7 School District

Lee's Summit, Missouri

Package 3 – Building & Site Permit Set

Volume 4 of 4 – Division 26 through Division 33

DLR Group Project No. 13-20102-00

October 8, 2020

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I hereby certify that this specification was prepared by me or under my direct supervision
and that I am a duly Licensed Architect under the laws of the State of Missouri.



Scott Pashia

License No. 7347

I hereby certify that this specification was prepared by me or under my direct supervision
and that I am a duly Licensed Professional Engineer under the laws of the State of Missouri.



Derek Joseph Smith

License No. 2007012527

I hereby certify that this specification was prepared by me or under my direct supervision
and that I am a duly Licensed Professional Engineer under the laws of the State of Missouri.



Carl J. Holden

License No. 2020016283

Oct 7 2020

I hereby certify that this specification was prepared by me or under my direct supervision
and that I am a duly Licensed Professional Engineer under the laws of the State of Missouri.



Christopher J. Culp License No. 2013037646

Oct 7 2020

I hereby certify that this specification was prepared by me or under my direct supervision
and that I am a duly Licensed Professional Engineer under the laws of the State of Missouri.



Curtis A. Olds License No. 2018036640

Oct 7 2020

I hereby certify that this specification was prepared by me or under my direct supervision
and that I am a duly Licensed Landscape Architect under the laws of the State of Missouri.



David H. Contag

License No. 000148

END OF SECTION 000105

SECTION 260010 - GENERAL ELECTRICAL REQUIREMENTS

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 and to all following sections within Division 26.

1.2 SECTION INCLUDES

- A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the Work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.
- B. Division 26 of these Specifications, and Drawings numbered with prefixes E, generally describe these systems, but the scope of the electrical work includes all such work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.
- C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, outlets and circuits without showing all of the exact details as to elevations, offsets, control lines, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.3 DEFINITIONS

- A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:
 - 1. Furnish: "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."
 - 2. Install: "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension,

finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use.”

3. Provide: “To furnish and install complete, and ready for the intended use.”
 4. Furnished by Owner (or Owner-Furnished) or Furnished by Others: “An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division.
 5. Engineer: Where referenced in this Division, “Engineer” is the Engineer of Record and the Design Professional for the Work under this Division.
 - a. A Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the “Architect”.
 6. Contract Administrator: Where referenced in this Division, “Contract Administrator” is the primary liaison between the Owner and the Contractor. Specifically, for this project this is “the Architect”.
 7. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
 8. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTLs that are acceptable to the AHJ, and standards that meet the specified criteria.
 9. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
 - a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
 10. Value Engineering: A systematic method to improve the “value” of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
- B. The terms "approved equal", “equivalent”, or "equal" are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

- C. Manufacturers: The listing of specific manufacturers does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed are not relieved from meeting these specifications in their entirety.
- D. The following definitions apply to excavation operations:
 - 1. Additional Excavation: Where excavation has reached indicated sub-grade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
 - 2. Sub-base: as used in this section refers to the compacted soil layer used in pavement systems between the sub-grade and the pavement base course material.
 - 3. Sub-grade: as used in this section refers to the compacted soil immediately below the slab or pavement system.
 - 4. Unauthorized excavation consists of removal of materials beyond indicated sub-grade elevations or dimensions without specific direction from the Contract Administrator.

1.4 REFERENCE STANDARDS

- A. Execute all work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Contract Administrator's and Engineer's attention in sufficient time, prior to the opening of bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.
- B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator and Engineer, without additional compensation. Contractor will be held responsible for any violation of the law.
- C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.
- D. All material, manufacturing methods, handling, dimensions, methods of installation, and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them:
 - IBC International Building Code
 - ADA Americans with Disabilities Act
 - AIA Guidelines for Design and Construction of Hospital and Healthcare Facilities
 - AEIC Association of Edison Illuminating Companies

ANSI	American National Standards Institute
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CSA/USA	Canadian Standards Association/USA
ICEA	Insulated Conductors Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code, NFPA 70
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers' Association
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Act
UL	Underwriter's Laboratories

- E. Comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. Perform all electrical work in compliance with applicable safety regulations, including OSHA regulations. All safety lights, guards, and warning signs required for the performance of the electrical work shall be provided by the Contractor.
- G. Obtain and pay for all permits, licenses and fees that are required by the governing authorities for the performance of the electrical work.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with other divisions for electrical work included in them but not listed in Division 26 or indicated on electrical Drawings.
- B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any work covered by this Division.
- C. Refer to Drawings and divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Make all offsets required to clear equipment, beams and other structural members, and to facilitate concealing conduit in the manner anticipated in the design.
- D. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes actually installed.
- E. Maintain an electrical foreman on the jobsite at all times to coordinate this work with other trades so that various components of the electrical systems is installed at the proper time, fits the available space, and allows proper service access to all equipment. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.

- F. Work of this Division shall progress according to the "Construction Schedule" as described in Division 01 and as approved by the Contract Administrator. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.

1.6 MEASUREMENTS AND LAYOUTS

- A. The Drawings are schematic in nature, which show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

1.7 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements, in addition to requirements specified herein.
- B. Submittals and shop drawings shall not contain Henderson Engineer's firm name or logo, nor shall they contain the Henderson Engineer's seal and signature. They shall not be copies of Henderson Engineer's work product. If the Contractor desires to use elements of such product, the license agreement for transfer of information at the end of this section must be used.
- C. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division. Provide the number of submittals required by Division 1; if hard-copy sets are provided, submit a minimum of seven (7) sets. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- D. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- E. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
- F. Refer to individual sections for additional submittal requirements.
- G. Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time, plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittals, if required. Transmit submittals as soon as possible after Notice to Proceed and before electrical construction starts.
- H. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

- I. Submittals shall contain the following information:
 - 1. The project name.
 - 2. The applicable specification section and paragraph.
 - 3. Equipment identification acronym as used on the drawings.
 - 4. The submittal date.
 - 5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
 - 6. Submittals not so identified will be returned to the Contractor without action.
- J. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contractor Administrator's and Engineer's designated representatives. Contractor shall allow for the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.
- K. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from the Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.

1.8 SUBSTITUTIONS

- A. Refer to Division 1 and General Conditions for substitutions in addition to requirements specified herein.
- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:
 - 1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
 - 2. The burden of proof of the merit of the proposed substitution is upon the proposer.

3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
 - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
 - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
 - c. Proposed substitution has received necessary approvals of the Authorities Having Jurisdiction.
 - d. Same warranty will be furnished for proposed substitution as for specified Work.
 - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
 - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.
- E. Substitution Consideration:
 1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
 2. No substitutions will be considered prior to receipt of bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of bids.
 3. If the proposed substitution is approved prior to receipt of bids, such approval will be stated in an addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
 4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.9 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet.
- B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.
- C. Contact the Architect for Architect's written authorization.
- D. The following must be received before electronic drawing files will be sent:

1. Architect's written authorization
2. Engineer's release agreement form
3. Payment

1.10 QUALITY ASSURANCE

- A. Execute all work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the work specified.
- B. Install all work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.
- C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

1.11 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish to the Contract Administrator, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- E. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees.
- F. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Contract Administrator and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the

website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives.

1.12 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections of this Division

1.13 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.
- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Contract Administrator.

1.14 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Contract Administrator.
- D. Be responsible for the safe storage of tools, material and equipment.

1.15 WARRANTIES

- A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified herein.

- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- C. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in these Construction Documents or manufacturer's standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 01.
- D. Also warrant the following additional items:
 - 1. All raceways are free from obstructions, holes, crushing, or breaks of any nature.
 - 2. All raceway seals are effective.
 - 3. The entire electrical system is free from all short circuits and unwanted open circuits and grounds.
- E. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.
- F. Perform the remedial work promptly, upon written notice from the Contract Administrator or Owner.
- G. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.16 TEMPORARY FACILITIES

- A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.
- B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.
- C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.
 - 1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.
 - 2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees F. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Vent fuel-burning heaters,

and equip units with individual-space thermostatic controls. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

1.17 FIELD CONDITIONS

A. Conditions Affecting Work In Existing Buildings: The following project conditions apply:

1. The Drawings describe the general nature of remodeling to the existing building; however, visit the site prior to submitting bid to determine the nature and extent of work involved.
2. Schedule work in the existing building with the Owner.
3. Perform certain demolition work prior to the remodeling. Perform the demolition that involves electrical systems, Light fixtures, equipment, raceways, equipment supports or foundations and materials.
4. Remove articles that are not required for the new work. Unless otherwise indicated, remove each item removed during this demolition from the premises and dispose in accordance with applicable federal, state and local regulations.
5. Relocate and reconnect electrical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where electrical equipment or materials are removed, cap unused raceways below the floor line or behind the wall line to facilitate restoration of finish.
6. Finish material will be installed under other divisions.
7. Obtain permission from the Contract Administrator for channeling of floors or walls not specifically noted on the Drawings.
8. Protect adjacent materials indicated to remain. For work specific to this Division, install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
9. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, provide temporary services for affected areas.

B. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services that transit the area affected by selective demolition.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

C. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.

- D. Use of explosives is not permitted.
- E. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

2.1 SOIL MATERIALS

- A. Sub base Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, or natural or crushed sand.
- B. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2-inch sieve, and not more than 5 percent passing a No. 4 sieve.
- C. Backfill and Fill Materials: Materials complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP; free of clay, rock, or gravel larger than two inches in any dimension; debris; waste; frozen materials; and vegetable and other deleterious matter.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 PERMITS

- A. Secure and pay for all permits required in connection with the installation of the Electrical Work. Arrange with the various utility companies for the installation and connection of all required utilities for this facility and pay all charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.3 TEMPORARY ELECTRICAL SERVICE AND WIRING

- A. Provide 208Y/120 volt, three-phase, four-wire, temporary electrical service and temporary lighting system to facilitate construction.
- B. Pay all charges made by the Electric Utility, with respect to installation and energy charges for temporary services.
- C. Work for the temporary power shall consist of all labor and materials, including, but not limited to conduit, wiring, panelboards, fuse blocks, fused disconnecting switches, fuses, pigtails, receptacles, wood panel switch supports, and other miscellaneous materials required to complete the power system.
- D. Install all temporary wiring in accordance with applicable codes, and maintain in an OSHA-approved manner.

- E. Provide an adequate number of GFCI type power distribution centers, rated 208Y/120V, four-wire, and not less than 60A, with sufficient fuse blocks or breakers for lighting and hand tool circuits, 60A four-wire feeders, all mounted within pre-fabricated enclosures UL listed for this application or on suitable wood panels bolted to columns or upright wood supports as required.
- F. Install circuits to points on each level of each building so that service outlets can be reached by a 50-foot extension cord for 120V power and a 100-foot extension cord for 208V power (or as required by OSHA or local authorities).
- G. Provide one lighting outlet per 30 linear feet of corridor and at least one light in each room and for every 800 square feet of floor area. Temporary lighting shall comply with OSHA requirements.
- H. If additional service is required for cranes, electrical welders or for electric motors over 1/2 HP per unit, such additional service shall become the responsibility of the trade involved.
- I. When the permanent wiring for lighting and power is installed, with approval of the Contract Administrator and Owner, the permanent system may be used, provided the Contractor assumes full responsibility for all electrical material, equipment, and devices contained in the systems and provided that roof drainage system and roofing are complete.
- J. When directed by the Contract Administrator, remove all temporary services, lighting, wiring and devices from the property.

3.4 ACCESS TO EQUIPMENT

- A. Locate all pull boxes, junction boxes and controls so as to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to Division 26 Section "Common Work Results for Electrical".
- B. Maintain all code required clearances and clearances required by manufacturers.

3.5 PENETRATIONS

- A. Unless otherwise noted as being provided under other divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions and ceilings for all electrical work that passes through construction. Refer to Division 26 Section "Common Work Results for Electrical".
- B. Provide sleeves, box frames, or both, for all conduit, cable, and busways that pass through masonry, concrete or block walls.
- C. The cutting of new and/or existing construction will not be permitted except by written approval of the Contract Administrator.

3.6 EXCAVATION AND BACKFILLING

- A. Refer to Division 01, Division 02 and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.

- B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this division. Excavation shall be in conformance with applicable Divisions and sections of the Specifications.
- C. Restore roads, alleys, streets and sidewalks damaged during this work to the satisfaction of Authorities Having Jurisdiction.
- D. Do not excavate trenches close to walks or columns without prior consultation with the Contract Administrator.
- E. Erect barricades around excavations, for safety, and place an adequate number of amber lights on or near the work and keep those burning from dusk to dawn. Be responsible for all damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.
- F. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.
- G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
 - 1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.
- H. Install sediment and erosion control measures in accordance with local codes and ordinances.
- I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
 - 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
 - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.
- J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
 - 1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
 - 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
- K. Excavation for Underground Tanks and Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of one inch in diameter and larger with emulsified asphalt tree paint.
 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- L. Trenching: Excavate trenches for electrical installations as follows:
1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of six to nine inches clearance on both sides of raceway and cables.
 2. Excavate trenches to depth indicated or required for raceway and cables to establish slope, away from buildings and indicated elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
 3. Limit the length of open trench to that in which raceway and cables can be installed, tested, and the trench backfilled within the same day.
 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceway and cables. Provide a minimum of six inches of stone or gravel cushion between rock bearing surface and raceway and cables.
 5. Excavate trenches for raceway, cables, and equipment with bottoms of trench to accurate elevations for support of raceway and cables on undisturbed soil.
- M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.
- N. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
 2. Under building slabs, use drainage fill materials.
 3. Under raceway and cables, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
 4. For raceway and cables less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation and testing of raceway and cables, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
 5. Other areas use excavated or borrowed materials.
- O. Backfill excavations as promptly as work permits, but not until completion of the following:
1. Inspection, testing, approval, and locations of underground utilities have been recorded.
 2. Removal of concrete formwork.

3. Removal of shoring and bracing, and backfilling of voids.
 4. Removal of trash and debris.
- P. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
1. For vertical and diagonal raceway installations, thoroughly support raceways from permanent structures or undisturbed earth at no less than 10-foot intervals, while placing backfill materials, so that raceways are not deflected, crushed, broken, or otherwise damaged by the backfill placement.
- Q. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- R. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.
- S. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:
1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
 - a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
 2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.
- T. Subsidence: Where subsidence occurs at mechanical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.7 CUTTING AND PATCHING

- A. Provide all necessary cutting of walls, floors, ceilings and roofs for work under this Division.
- B. Cut no structural member without permission from Contract Administrator.
- C. Patch around all openings to match adjacent construction.
- D. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Contract Administrator.

3.8 PAINTING

- A. Refer to Division 09 Section "Painting" for painting requirements.
- B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.
- C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
- D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
- E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

3.9 CLEANING

- A. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to final inspection, make a final cleanup of dirt and refuse resulting from the Work and assist in making the premises broom clean. Clean all material and equipment installed under this Division.
- C. Remove dirt, dust, plaster, stains, and foreign matter from all surfaces.
- D. Touch up and restore damaged finishes to their original condition.

3.10 ADJUSTING, ALIGNING AND TESTING

- A. Adjust, align and test all electrical equipment furnished and/or installed under this Division.

- B. Check motors for alignment with drive and proper rotation, and adjust as required.
- C. Check and test protective devices for specified and required application, and adjust as required.
- D. Check, test and adjust adjustable parts of all light fixtures and electrical equipment as required to produce the intended performance.
- E. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.
- F. After completion, perform tests for continuity, unwanted grounds, and insulation resistance in accordance with the requirements of NFPA 70 and NETA.
- G. Be responsible for the operation, service and maintenance of all new electrical equipment during construction and prior to acceptance by the Owner of the complete project under this Contract. Maintain all electrical equipment in the best operating condition including proper lubrication.
- H. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.
- I. Maintain service and equipment for all testing of electrical equipment and systems until all work is approved and accepted by the Owner.
- J. Keep a calibrated voltmeter and ammeter (true RMS type) available at all times. Provide service for test readings when and as required.
- K. Refer to individual sections for additional and specific requirements.

3.11 START-UP OF SYSTEMS

- A. Prior to start-up of electrical systems, check all components and devices, lubricate items appropriately, and tighten all screwed and bolted connections to manufacturers' recommended torque values using appropriate torque tools.
- B. Each power, lighting and control circuit shall be energized, tested and proved free of breaks, short-circuits and unwanted grounds.
- C. Adjust taps on each transformer for rated secondary voltages.
- D. Balance all single phase loads at each panelboard, redistributing branch circuit connections until balance is achieved to plus or minus 10 percent.
- E. Replace all burned-out lamps. Replace the lamps of all light fixtures that use incandescent, halogen or quartz lamp sources that are installed as part of the finished building, but are used by the Contractor during construction, with new lamps of appropriate type and wattage prior to turning the facility over to the Owner.
- F. After all systems have been inspected and adjusted, confirm all operating features required by the Drawings and Specifications and make final adjustments as necessary.

- G. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.
- H. At the time of final review and tests of the power and lighting systems, all equipment and system components shall be in place and all connections at panelboards, switches, circuit breakers, and the like, shall be complete. All fuses shall be in place, and all circuits shall be continuous from point of service connections to all switches, receptacles, outlets, and the like.

3.12 TEST REPORTS

- A. Perform tests as required by these Specifications and submit the results in the operations and maintenance manuals. The tests shall establish the adequacy, quality, safety, and reliability for each electrical system installed. Notify the Contract Administrator and Engineer two working days prior to each test.
- B. For specific testing requirements of special systems, refer to the Specification section that describes that system.
- C. Upon completing each test, record the results, date and time of each test and the conditions under which the test was conducted. Submit to the Contract Administrator, for Engineer's review, in duplicate, the test results for the following electrical items:
 - 1. Building service entrance voltage and amperes at each phase.
 - 2. Electrical service grounding conditions and grounding resistance.
 - 3. Proper phasing throughout the entire system.
 - 4. Voltages (phase-to-phase and phase-to-neutral) and amperes at each phase for each panelboard, switchboard, and the like.
 - 5. Phase voltages and amperes at each three-phase motor.
 - 6. Test all wiring devices for electrical continuity and proper polarity of connections.
- D. Promptly correct all failures or deficiencies revealed by these tests as determined by the Engineer.

3.13 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:
 - 1. Submit complete Operation and Maintenance Data.
 - 2. Submit complete Record Drawings.
 - 3. Perform all required training of Owner's personnel.
 - 4. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.

5. Perform start-up tests of all systems.
 6. Remove all temporary facilities from the site.
 7. Comply with all requirements for Substantial Completion in the Division 01 and General Conditions.
- B. Request in writing a review for Substantial Completion. Give the Contract Administrator at least seven (7) days notice prior to the review.
- C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, he shall reimburse the Contract Administrator and Engineer for time and expenses incurred for the visit.
- F. Upon completion of the review, the Contract Administrator will prepare a “final list” of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the “final list” shall not relieve the Contractor from the requirements of the Contract Documents.

- H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 260010

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples
☐ Tests ☐ Reports ☐ Other: _____

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____ Submitting Contractor	_____ Date	_____ Company
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Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____ Manufacturer's Representative	_____ Date	_____ Company
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Engineer Review and Recommendation Section

Recommend Acceptance	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Additional Comments:	<input type="checkbox"/> Attached	<input type="checkbox"/> None

Acceptance Section:

_____ Contractor Acceptance Signature	_____ Date	_____ Company
_____ Owner Acceptance Signature	_____ Date	_____ Company
_____ Architect Acceptance Signature	_____ Date	_____ Company
_____ Engineer Acceptance Signature	_____ Date	_____ Company

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This Section includes limited scope general construction materials and methods, electrical equipment coordination, and common electrical installation requirements as follows:
 - 1. Access doors in walls, ceilings, and floors for access to electrical materials and equipment.
 - 2. Sleeves and seals for electrical penetrations.
 - 3. Joint sealers for sealing around electrical materials and equipment, and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
 - 4. Sealing penetrations through noise critical spaces.

1.2 DEFINITIONS

- A. The following abbreviations apply to this and other Sections of these Specifications:
 - 1. AHJ: Authority(ies) having Jurisdiction
 - 2. ATS: Acceptance Testing Specifications
 - 3. EPDM: Ethylene-propylene-diene monomer rubber
 - 4. MC: Metal Clad
 - 5. NBR: Acrylonitrile-butadiene rubber
 - 6. NRTL: Nationally Recognized Testing Laboratory
 - 7. PCF: Pounds per Cubic Foot
- B. The following definitions apply to this and other Sections of these Specifications:
 - 1. Homerun: That portion of an electrical circuit originating at a junction box, termination box, receptacle or switch with termination at an electrical panelboard. Note: Where MC Cable is utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first load.

1.3 ADMINISTRATIVE REQUIREMENTS

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

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 3. To allow right of way for piping, ducts, and other systems installed at required slopes and/or elevations.
 4. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
- D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”:
1. Product data for the following products:
 - a. Sleeve seals.
 - b. Through and membrane penetration firestopping systems.
 2. Shop drawings for:
 - a. Detailed fabrication drawings of access panels and doors.
 3. Through and Membrane Penetration Firestopping Systems Product Schedule: Provide UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
 - a. Where Project conditions require modification to qualified testing and inspecting agency's illustrations for a particular firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
 - b. Qualifications data for testing agency.
 4. Record Drawings: Submit Record Drawings as required by Division 1 and Division 26
 - a. Accurately record actual locations of firestopped penetrations and access panel/door locations. Indicate dimensions from fixed structural elements.

1.5 NOISE CRITICAL SPACES

- A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces that will require application of sound attenuating measures and acoustical sealants.
1. Patient Care/Nurse Areas
 2. Offices
 3. Conference Rooms
 4. Classrooms
 5. Learning Areas
 6. Choir Spaces
 7. Media Center Areas
 8. Library Areas
 9. A/V Spaces
 10. TV Production Studio
 11. Drama Space
 12. Music Teaching Spaces
 13. Meeting/Banquet Rooms
 14. Conference Rooms

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- B. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.2 ACCESS TO EQUIPMENT

A. Manufacturers:

1. Bar-Co., Inc.
2. Elmdor Stoneman.
3. JL Industries
4. Jay R. Smith Mfg. Co.
5. Karp Associates, Inc.
6. Milcor
7. Nystrom Building Products
8. Wade
9. Zurn

B. Access Doors:

1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section "Identification for Electrical Systems" for labeling of access doors.
2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
3. Access doors must be of the proper construction for type of construction where installed.
4. The exact location of all access doors shall be verified with the Contract Administrator prior to installation.
5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
 - b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.

7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
8. Locking Devices: Flush, screwdriver-operated cam locks.

2.3 SLEEVES

A. Steel sleeves for raceways and cables

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends and drip rings.

B. Cast iron wall pipe sleeves for raceways and cables

1. Manufacturers
 - a. Josam Mfg. Co.
 - b. Smith (Jay R) Mfg. Co.
 - c. Tyler Pipe/Wade Div.; Subs of Tyler Corp.
 - d. Watts Industries, Inc.
 - e. Zurn Industries, Inc.; Hydromechanics Div.
2. Cast-iron sleeve with integral clamping flange with clamping ring, and nuts for membrane flashing.
 - a. Underdeck Clamp: Clamping ring with setscrews.
3. Sleeves for rectangular openings: Galvanized sheet steel with minimum 0.052- or 0.138- inch thickness as indicated and of length to suit application.
4. Coordinate sleeve selection and application with selection and application of firestopping to be used.

2.4 SEALANTS

A. SLEEVE SEALS

1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
2. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.

- c. Metraflex Co.
 - d. O-Z/Gedney
 - e. Pipeline Seal and Insulator, Inc.
3. Sealing Elements: Interlocking or solid sealing links shaped or pre-drilled to fit surface of cable or raceway. Include type and number required for material and size of raceway or cable.
- a. EPDM
 - b. NBR
 - c. Neoprene
4. Pressure Plates: Include two for each sealing element. For multi-phase circuits, use slotted pressure plates if metal.
- a. Plastic
 - b. Carbon steel
 - c. Stainless steel
 - d. PVC-coated steel
5. Connecting Bolts and Nuts: of length required to secure pressure plates to sealing elements. Include one for each sealing element.
- a. Carbon steel with corrosion-resistant coating
 - b. Stainless steel

B. JOINT SEALERS

- 1. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- 2. Colors: As selected by the Contract Administrator from manufacturer's standard colors.
- 3. Elastomeric Joint Sealers: Provide the following types:
 - a. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.
 - b. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.

- c. Products: Subject to compliance with requirements, provide one of the following:
 - 1) One-Part, Nonacid-Curing, Silicone Sealant:
 - a) "Dow Corning 790," Dow Corning Corp.
 - b) "Dow Corning 795," Dow Corning Corp.
 - c) "Silglaze N SCS 2801," General Electric Co.
 - d) "Silpruf SCS 2000," General Electric Co.
 - e) "864," Pecora Corp.
 - f) "Omniseal," Sonneborn Building Products Div
 - g) "Spectrem 1," Tremco, Inc.
 - h) "Spectrem 2," Tremco, Inc.
 - 2) One-Part, Mildew-Resistant, Silicone Sealant:
 - a) "Dow Corning 786," Dow Corning Corp.
 - b) "Sanitary 1700," General Electric Co.
 - c) "898 Silicone Sanitary Sealant," Pecora Corp.
 - d) "OmniPlus," Sonneborn Building Products Div.
 - e) "Tremsil 600 White," Tremco Corp.
- 4. Acrylic-Emulsion Sealants: One-part, non-sagging, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) "Chem-Calk 600," Bostik
 - 2) "AC-20," Pecora Corp.
 - 3) "Sonolac," Sonneborn Building Products Div.
 - 4) "Tremflex 834," Tremco, Inc.

C. FIRESTOPPING

- 1. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, by Underwriters' Laboratories, Inc., or other NRTL acceptable to AHJ.

- a. Manufacturers:
 - 1) Hilti, Inc.
 - 2) RectorSeal.
 - 3) Specified Technologies Inc.
 - 4) 3M Corp.
 - 5) United States Gypsum Company.

D. ACOUSTICAL SEALANTS sealants

- 1. Foam Backer Rod: Closed cell polyethylene suitable for use as a backing for non-hardening sealant.
- 2. Non-Hardening Penetration Sealant: Non-hardening polysulphide type, Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.
- 3. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 PCF (40 kg/m3).

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".
- C. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)
- D. Comply with NECA 1.
- E. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless indicated otherwise.
- F. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- G. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

- H. Right of Way: Yield to raceways and piping systems installed at a required slope.

3.2 ACCESS DOORS

- A. Coordinate with architectural finishes to set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.
- C. Label all access doors with a nameplate as described in Division 26 Section "Identification for Electrical Systems".

3.3 SLEEVES AND SLEEVE SEALS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Provide sleeves for required openings in all concrete and masonry construction and fire, smoke, or both, partitions, for all electrical work that passes through such construction. Coordinate with all other trades and divisions to dimension and lay out all such openings.
- C. Only those openings specifically indicated on the Architectural or Structural Drawings will be provided under other divisions.
- D. New Construction:
 - 1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support raceway penetrations.
- E. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls. Do not cut or core drill new construction without written approval from the Contract Administrator and Structural Engineer.
- F. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- G. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
 - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
- H. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- I. Install pipe and rectangular sleeves in above-grade walls and slabs, where penetrations are not subject to hydrostatic water pressures. Ensure that drip ring is fully encased and sealed within the wall or slab.

- J. Cut sleeves to length for mounting flush with both surfaces of walls.
- K. Extend sleeves installed in floors 2 inches above finished floor level.
- L. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed; in which case, size sleeves as recommended by the seal manufacturer.
- M. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- N. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint
- O. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.
- P. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- Q. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (or larger, if required by the seal manufacturer) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- R. Above Grade Concrete or Masonry Penetrations
 - 1. Provide sleeves for cables or raceways passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:
 - a. Install schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
 - b. Install galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 0.138 inches.
 - c. Install galvanized sheet metal for rectangular sleeves
 - d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.
 - 2. Seal elevated floor, exterior wall and roof penetrations watertight and weather tight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of 1/2" of sealant.
- S. Underground, Exterior-Wall Penetrations: Install cast-iron wall pipes for sleeves. Size sleeves to allow for 1-inch (or larger, if required by the mechanical sleeve manufacturer) annular clear space between sleeve and cable or raceway. Provide mechanical sleeve seal.
 - 1. Use type and number of sealing elements recommended by manufacturer for pipe material and size. Position pipe in center of sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

2. Inspect installed sleeve and sleeve-seal installation for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade to seal against hydrostatic pressure.

T. Elevated Floor Penetrations of waterproof membrane:

1. Provide cast-iron wall pipes for sleeves. Size wall pipe for minimum ½" annular space between wall pipe and cable or raceway.
2. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant.
3. Secure waterproof membrane flashing between clamping flange and clamping ring.
4. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.

U. Interior Foundation Penetration: Provide sleeves for horizontal raceway passing through or under foundation. Sleeves shall be cast iron soil pipe two normal pipe sizes larger than the pipe served.

V. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and cable or raceway, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

W. Exterior Wall Penetrations: Seal annular space between sleeve and raceway or duct, using joint sealant for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant.

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

Y. Sleeve-Seal Installation

1. Install sleeve seals for all underground raceway penetrations through walls at elevations below finished grade. Additionally, install seals inside raceways, after conductors or cables have been installed, in all raceway penetrations through walls at elevations below finished grade.
2. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Z. Inspect installed sleeve and sleeve-seal installations for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade and above grade where installed to seal against hydrostatic pressure.

3.4 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire/smoke-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.5 JOINT SEALERS

A. Preparation for Joint Sealers

1. Clean surfaces of penetrations, sleeves, or both, immediately before applying joint sealers, to comply with recommendations of joint sealer manufacturer.
2. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

B. Application of Joint Sealers

1. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - a. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - b. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
2. Tooling: Immediately after sealant application and prior to time shining or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

C. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical raceways penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.6 ACOUSTICAL PENETRATIONS

- A. Do not allow direct contact of raceways with shaft walls, floor slabs and/or partitions. Sleeve, pack and seal airtight with foam rod, non-hardening sealant and/or packing material, as described herein, for all penetrations by raceway, through surfaces that encompass or are between noise critical spaces. Seal and pack with caulking for the full depth of the penetration all openings around raceways in the structure surrounding the electrical equipment and surrounding noise-critical spaces. This includes all slab penetrations and penetrations of noise critical walls.
- B. Where a raceway passes through a wall, ceiling or floor slab of a noise critical space, cast or grout a metal sleeve into the structure. The internal diameter or dimensions of the sleeve shall be 2 inches larger than the external diameter or dimensions of the raceway passing through it. After all of the raceways are installed in that area, check the clearances and correct, if necessary, to within 1/2-inch. Pack the voids full depth with packing material sealed at both ends, 1-inch deep, with non-hardening sealant backed by foam rod.

END OF SECTION 260500

SECTION 260502 - EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This Section includes limited scope for electrical connections to equipment specified under other sections or divisions, or furnished under separate contracts or by the Owner.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Unless otherwise noted, perform all electrical work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this contract.
- B. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.
- C. Determine connection locations and rough-in requirements based on shop drawings.
- D. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.
- E. Sequence electrical connections to coordinate with start-up schedule for equipment.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product data for the following products for:
 - 1. Special connectors
 - 2. Special conductors or cable assemblies.
- C. Shop drawings for:
 - 3. Detailing electrical characteristics, wiring diagrams, fabrication and installation for wiring systems.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories:
 - 4. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to Authorities Having Jurisdiction.

- 5. Marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.1 CORDS AND CAPS

- A. Attachment Plugs: Conform to NEMA WD 1.
- B. Configuration: NEMA WD 6, matching receptacle configuration at outlet provided for equipment, or as required by the equipment manufacturer.
- C. Cord: See Paragraph "Flexible Cords" in Division 26 Section "Low-voltage Electrical Power Conductors and Cables".
- D. Provide cord size suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify conditions of equipment and installation prior to beginning work.
- B. Verify that equipment is ready for connecting, wiring, and energizing.

3.2 INSTALLATION, GENERAL

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

3.3 ELECTRICAL DEVICES

- A. Install disconnect switches, controllers, control stations, and control devices (other than temperature control devices) specified in other divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

3.4 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturers' instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.
- C. Make wiring connections using conductors and cable with insulation suitable for temperatures encountered in heat producing equipment.

- D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated on the Drawings.
- E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- F. Provide interconnecting conduit and wiring between devices and equipment where indicated on the Drawings.

3.5 HVAC EQUIPMENT

- A. When equipment is delivered in separate parts and field assembled, internal wiring, indicated on Shop Drawings as field wiring, will be provided by the equipment supplier, unless otherwise noted.
- B. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.
- C. Provide all control and interlock wiring for all equipment that is not included within the responsibility of Division 22 or 23.

3.6 FOOD SERVICE (SERVERY) EQUIPMENT

- A. Provide power connection to all equipment as indicated or as otherwise required to accommodate the equipment indicated in the food service equipment drawings and specifications.
- B. Coordinate and provide the appropriate receptacle for actual equipment being installed as required for proper operation. Coordinate the required quantity of conductors prior to pulling wire to outlet box.
- C. Provide a local recessed non-fused equipment disconnect for kitchen equipment as required by the applicable codes and jurisdictions. Coordinate exact location prior to rough-in and maintain all code required clearances.
- D. Provide control wiring and conduit for all equipment that is not indicated as being within the responsibility of the equipment manufacturer or installer.
- E. When equipment is delivered in separate parts and field assembled, internal wiring, indicated on Shop Drawings as field wiring, shall be provided by the equipment installer, unless otherwise noted.
- F. Coolers and Freezers: Cut conduit openings in freezer and cooler walls, floor, and ceilings, in accordance with manufacturers' instructions, when openings are not provided by the manufacturers. Seal around conduit penetrations air tight with an approved pliable material suitable for low temperatures. Effectively seal interiors of conduits, by installing a conduit fitting at the boundary of the two spaces, and filling it with an approved pliable material, after conductors or cables have been installed and tested.
- G. Provide all grounding systems as required by the equipment supplier.

3.7 DOOR OPERATORS AND HARDWARE

- A. Provide electrical connections to automatic entry doors, automatic corridor doors, electrically held door latches, remote release doors, and all other required electrical connections for door systems included in other sections of these specifications.

- B. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.
- C. Provide all control wiring and conduit for all equipment that is not included within the responsibility of the door hardware installer. Provide connection from junction boxes to the door operators or hardware and from door operators to actuation devices as required. Install key operated switches, push pad switches, and other electrically controlled door operation devices furnished by other divisions within this contract.
- D. Provide fire alarm devices and wiring as required for proper operation of door systems in accordance with the NFPA codes.
- E. END OF SECTION**

SECTION 260504 - PROVISIONS FOR ELECTRIC UTILITY SERVICE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes:
 - 1. Provisions for Underground Secondary Electrical Service.
- B. Utility service voltage:
 - 1. As indicated on the Drawings.
- C. Utility service ampacity: As indicated on the Drawings.
- D. The extent of Work for the secondary electrical service includes providing the following:
 - 1. Raceways
 - 2. Provisions for Metering
 - 3. Grounding and Bonding
 - 4. Concrete pad for service transformer(s)
 - 5. Service lateral

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Product data for the following products for:
 - a. Meter bases
 - b. Current transformer cabinets
 - 2. Shop drawings for:
 - a. Utility Company prepared installation drawings
 - b. Cast-in-place concrete pads
- B. Where equipment or materials are specified to comply with utility standards and are listed above as required submittals, obtain approval from the serving utility before submitting to the Architect.

- C. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section “General Electrical Requirements”:

1. Accurately record actual routing of all exterior buried raceway and all interior conduits two inches and larger. Indicate dimensions from fixed structural elements.

1.3 QUALITY ASSURANCE

- A. Perform all work in accordance with Utility Company installation drawings and service standards.
- B. Maintain one copy of Utility Company installation drawings and service standards at the site.
- C. Prior to commencing work in this Section, meet with the Utility Company representative to review service entrance requirements and details.
- D. Verify that field measurements are as indicated on Utility Company drawings.
- E. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that are acceptable to authorities having jurisdiction.
 - 2. Marked for intended use.
- F. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS (Not Used)

PART 3 - EXECUTION

3.1 SECONDARY SERVICE ENTRANCE UNDERGROUND

- A. Provide an underground secondary service lateral from the pad mounted transformer in accordance with NFPA 70 Article 230 and the Utility Company standards. Reference the Drawings for service lateral conductor and raceway quantities, sizes, and types.
- B. The Utility Company will provide the service transformer.
- C. Provide a concrete pad, complying with the Utility Company standards, for transformer mounting, and set coated GRS conduit elbows and riser(s), with grounding bushing(s), to receive primary and secondary raceways. Where direct burial primary is used, set coated GRS conduit elbow(s) and riser(s), with grounding bushing(s), to receive primary cables.
- D. Make connections to the secondary terminals of the transformer as required and in conformance with Utility Company requirements. Utility Company will provide primary conductors and terminal connections unless otherwise directed by the Utility Company.

3.2 METERING

- A. Provide a 1-1/4-inch empty GRS conduit, with pull cord, from the current transformer compartment of service entrance equipment to the meter location indicated on the Drawings, or as directed by the Utility Company.
- B. Provide a meter base complying with the Utility Company standards.
- C. Provide a current transformer cabinet complying with the Utility Company standards.
- D. The Utility Company will provide the meter and meter wiring.

3.3 UTILITY SERVICE CHARGES

- A. It shall be the responsibility of the Division 26 contractor to apply for the electrical service, including the preparation and completion of all forms. Submit the completed application along with all other required documentation for the new or modified service.
- B. Pay all Utility Company charges for providing electric service, including all charges for bringing primary service conductors to the site.

END OF SECTION

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes:
 - 1. Conductors, cables, and cords rated 600V and less.
 - 2. Connectors and terminations rated 600V and less.

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Product data for the following products:
 - a. Metal Clad (MC) cable and fittings.
- B. Field Quality-Control Test Reports: From Contractor.

1.3 ABBREVIATIONS AND DEFINITIONS

- A. The following abbreviations apply to this and other Sections of these specifications:
 - 1. MC: Metal Clad
 - 2. NBR: Acrylonitrile-butadiene rubber
- B. The following definitions apply to this and other Sections of these Specifications:
 - 1. HOMERUN: That portion of an electrical circuit beginning at a junction box, termination box, receptacle or switch with termination at an electrical panelboard. Note: Where MC Cable is allowed to be utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first (most upstream) load.

1.4 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

C. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
2. Marked for intended use.

D. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- B. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.2 CONDUCTORS AND CABLES

A. General

1. Manufacturers:
 - a. AFC Cable Systems, Inc.
 - b. Alan Wire
 - c. Cerrowire
 - d. Colonial Wire & Cable
 - e. Encore Wire Corporation
 - f. General Cable
 - g. Northern Cables Inc.
 - h. Okonite Company

- i. Southwire Company
 - 2. Conductor Material: Annealed (soft) copper complying with ICEA S-95-658/NEMA WC70 and UL Standards 44 or 83, as applicable; solid conductor for No. 10 AWG and smaller; concentric, compressed stranded for No. 8 AWG and larger and stranded for all flexible cords, cables, and control wiring.
 - 3. Conductor Insulation Types: Type THHN/THWN-2] [and/or] [XHHW-2] complying with ICEA S-95-658/NEMA WC70.
 - 4. Sizes of conductors and cables indicated or specified are American Wire Gage (Brown and Sharpe).
 - 5. Unless indicated otherwise, special purpose conductors and cables, such as low voltage control and shielded instrument wiring, shall be as recommended by the system equipment manufacturer.
 - 6. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
- B. Metal Clad Cable, Type MC (Do not use for life safety or critical systems.)
- 1. MC Cable (with insulated green grounding conductor, no bonding conductor):
 - a. Manufacturers:
 - 1) AFC Cable Systems, Inc (MC Lite)
 - 2) Encore Wire Corporation (MC)
 - 3) Kaf-Tech
 - 4) Southwire Company (Amorlite)
 - b. 600V, Unjacketed UL Standard 83, UL Standard 1569 for Type MC, UL Standard 1685, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and the NEC. Type MC Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.
 - c. Armor Assembly: Aluminum interlocked armor (aluminum color).
 - d. Phase Conductors: Solid soft-drawn copper, THHN-insulated single conductors, color code: ICEA Method 1.
 - e. Grounding Conductor: Solid soft-drawn copper, THHN/THWN-2 green insulated grounding conductor sized per NEC Table 250.122.
 - f. Marking: Cable markings shall comply with the requirements on NEC ART. 310.11.
 - 2. MC Cable (with 0-10V dimming control wiring):
 - a. Manufacturers:

- 1) AFC Cable Systems, Inc (MC- PCS)
- 2) Encore Wire Corporation (MC- LED)
- 3) Southwire Company (MC – PCS Duo)
- b. 600V, Unjacketed UL Standard 83, UL Standard 1569 for Type MC, UL Standard 1685, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and the NEC. Type MC Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.
- c. Armor Assembly: Aluminum interlocked armor (aluminum color).
- d. Phase Conductors: Solid soft-drawn copper, THHN-insulated single conductors, color code: ICEA Method 1.
- e. Grounding Conductor: Solid soft-drawn copper, THHN/THWN-2 green insulated grounding conductor sized per NEC Table 250.122.
- f. Control Conductors: color coded class2/class3 twisted jacketed pairs
- g. Marking: Cable markings shall comply with the requirements of NEC Art 310 .11(1).
3. MC Cable Fittings:
 - a. Manufacturer & Model:
 - 1) Arlington (4010 AST snap-in type): (SG38 saddle type)
 - 2) Crouse-Hinds (QLK Quick-Lok Series, Saddle type); ACB Series; set-screw, saddle type)
 - 3) O-Z Gedney (AMC-50 speed-lok, saddle type)
 - 4) Thomas & Betts (XC-730 Series cable-lok, saddle type); 3110 Series Tite-Bite)
 - b. Fittings used for connecting Type MC cable to boxes, cabinets, or other equipment shall be UL listed and identified for such use with an MCI-A marking on the fitting carton or package.
 - c. Fittings shall be insulated type not requiring the use of anti-short bushings.
 - d. Romex style, clamp type fittings are not acceptable.
- C. Single Conductors
 1. 600V, THHN/THWN-2insulated conductors, color-coded as follows:

PHASE	208Y/120V	480Y/277V
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
Neutral	White	Gray**
Equipment Ground	Green	Green
Isolated Ground	Green/Yellow Stripe	N/A

**Except as provided in NFPA 70.

2. Conductors shall not be smaller than No. 12 AWG, except that wiring for signal and pilot control circuits and pre-manufactured whips for light fixtures may be No. 14 AWG.

D. Flexible Cords

1. 300V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant black jacket, hard-usage; Type SJO for indoor dry locations; SJOW for damp, wet, and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.

E. Control Wiring

1. Refer to Division 23 Section "Direct-Digital Control for HVAC"
2. Unless otherwise noted, all control wiring will be the responsibility of the Section or Division in which the control system is specified.

F. Connectors

1. Manufacturers:
 - a. AMP; Tyco
 - b. FCI-Burndy
 - c. Gould
 - d. Ideal Industries, Inc.
 - e. Ilsco
 - f. NSi Industries, Inc.
 - g. O-Z/Gedney
 - h. Panduit
 - i. Thomas and Betts
 - j. 3-M Electrical Products Division

2. Compression connectors for conductors No. 8 AWG and larger: Long-barreled, UL 486-listed, bare copper, circumferential compression type (Burndy "Hylug", or equal), insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.
 - a. Termination fittings: 1-hole pad and inspection port.
3. Mechanical connections for conductors No. 8 AWG and larger: UL-listed, bare copper and/or tinned aluminum, dual-rated, mechanical type, insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.
 - a. Termination fittings: 1-hole pad and inspection port.
4. Connectors for solid conductors No. 10 AWG and smaller: Insulated winged wire nuts. Color-coded for size, except use green only for grounding connections.
5. Connectors for stranded conductors No. 10 AWG and smaller: Tinned copper, insulated-sleeve, compression type, UL-listed, with wire insulation grip. Terminations: ring-tongue type.
6. Connectors and terminations for aluminum conductors and cables No. 1 and larger: UL 486B listed and marked AL7CU for 75 deg C rated conductors and AL9CU for 90 deg C rated conductors.

PART 3 - EXECUTION

3.1 CONDUCTORS AND CABLES

A. General:

1. Unless otherwise indicated on the Drawings or in other Sections, install all conductors in raceway. Install continuous conductors between outlets, devices and boxes without splices or taps. Do not pull connections into raceways. Leave at least 8 inches of conductor at outlets for fixture or device connections.
2. Use manufacturer-approved pulling compound or lubricant where necessary; compound used shall not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
3. Use pulling means, including fish tape, cable, rope, and basket weave conductor/cable grips that will not damage conductors/cables or raceway.
4. Electrical conductor and cable work is schematically represented on the Drawings. Unless otherwise indicated, conductor sizes shown on the Drawings are based on not more than three single current-carrying conductors in a raceway in free air. Current ratings are based on copper at 75 degrees C temperature rating for all power circuits. Modify raceway and conductor sizing as may be necessitated by any deviation from these conditions. Do not decrease the indicated conductor size due to the use of conductors having a temperature rating of 90 degrees C.
5. Conductor sizes shown are minimum based on code requirements, voltage drop, and/or other considerations. Where approved by the Engineer and at no extra cost to the Owner, larger

conductor sizes may be installed at Contractor's option in order to utilize stock sizes, provided raceway sizes are increased where necessary to conform with NFPA 70 (determine the effect of the use of larger conductors on the short circuit current ratings of the electrical equipment, and provide increased short circuit current rated equipment as required).

6. Where parallel conductors are shown, install each set of conductors in separate raceways of essentially the same length.
7. Seal around cables penetrating fire-rated elements according to Division 07 Section "Penetration Firestopping".
8. Identify and color-code conductors and cables according to Part 2 of this Section .
9. Wiring at Outlets: Install conductors at each outlet with at least 6 inches of slack.
10. Common or Shared Neutrals are not allowed unless shown on the plans or specifically noted to be allowed.
11. Multi-wire branch circuits (i.e., shared neutral) shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point the branch circuit originates. Multi-pole breakers or 3 single pole breakers with a handle tie are two examples.
12. When multiple home runs are combined into a single raceway such that the number of conductors exceeds four (conductor count is made up of any combination of phase and neutral conductors), the following restrictions apply, which are in addition to those in NFPA 70:
 - a. Normal or Non-Essential circuits.
 - 1) Maximum of 16 conductors in a single raceway. For up to eight conductors in a raceway, minimum raceway size: 3/4 inch. For greater than eight conductors, minimum raceway size: 1 inch. Do not install any other type of circuit in this raceway.
 - 2) The minimum wire size for all conductors in this raceway: No. 10 AWG.
 - 3) Only 15A and 20A branch circuit homeruns may be combined into one raceway.
 - b. GFCI-protected circuits.
 - 1) Do not use multi-conductor circuits, with a shared neutral, for any GFCI circuit breaker or receptacle circuit.
13. For branch circuits fed from GFCI circuit breakers, limit the one-way conductor length to 100 feet between the panelboard and the most remote receptacle or load on the GFCI circuit.
14. Where the number of conductors for branch circuits is not shown on the Drawings, determine the number of conductors in accordance with NFPA 70. Provide adequate conductors so as to allow performance of all functions of the device.
15. Provide all conductors with 600V insulation of the following types, unless otherwise noted on the Drawings or in these Specifications:

- a. Wet or dry locations, in raceways:
 - 1) Service entrance: Type THWN, THHN/THWN-2, or XHHW.
 - 2) Feeders and branch circuits: Type THWN, THHN/THWN-2, or XHHW.
 - 3) Conductors No. 6 AWG and smaller: Types THWN or THHN/THWN-2.
- B. Aluminum Conductor Option:
 - 1. Aluminum conductors are not allowed.
- C. Metal Clad Type MC Cable:
 - 1. Securing and Supporting:
 - a. Support per Art 330 for MC cable
 - b. Secure cable within 12 inches of every box or fitting.
 - c. Secure/supporting intervals shall not exceed six (6) feet for MC cable.
 - d. Utilize steel cable hangers, Arlington SMC series or equivalent, for MC cable support wherever possible so as to provide for cable routing in a neat and workmanship like manner.
 - 2. Type MC cable may only be used:
 - a. In lieu of flexible conduit and wiring from light fixtures in accessible ceilings to junction boxes (attached to building structure) above the ceiling. Provide cable whips of sufficient lengths to allow for relocating each light fixture within a 5-foot radius of its installed location, but not exceeding 6 feet in unsupported lengths.
 - b. For vertical drops and horizontal wiring in stud walls.
 - c. In lieu of metal raceway, only for 15A and 20A branch circuits with up to four (4) conductors, not including grounding and/or bonding conductor(s), and only in dry concealed locations above grade, except where specifically not permitted by the NEC.
 - 3. MC Cable shall not be used for any use not listed in the paragraph above. Examples of those uses include, but are not limited to:
 - a. In locations not permitted by the NEC.
 - b. When specifically not allowed by the local AHJ and/or Owner.
 - c. Homeruns to panelboards. Note: where metal clad cable is utilized for receptacle, lighting, and/or miscellaneous load branch circuiting, the originating point of the homerun shall be at the first (most upstream) load in the circuit or at a junction box located in the accessible ceiling space immediately above the first (most upstream) load. Reference definitions in this section for definition on "Homerun".

- d. Where exposed to view.
- e. Where subject to physical damage.
- f. Corrosive or Hazardous locations.
- g. Wet locations.

D. Flexible Cords

- 1. Refer to Division 26 Section, ““Equipment Wiring Systems”, for electrical connections to equipment.

E. Control Wiring

- 1. Unless otherwise indicated on the Drawings or in other sections, install all control wiring in raceway, regardless of voltage. A qualified Electrician shall install all control wire operating at 120V nominal and above. Control wiring operating at less than 120V (e.g., 12V and 24V) may be installed under the Division furnishing it.
- 2. Open wiring in air-handling plenums: UL listed and classified for use in air plenums without raceway. Where indicated on the Drawings or specified, and permitted by local codes, only cable for communication or fire alarm systems and low voltage control wiring may be installed without raceways.

F. Connections:

- 1. Apply a zinc based, anti-oxidizing compound to connections.
- 2. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- 3. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- 4. Use only resin pressure splices and splicing kits that totally encapsulate the splice for splices in underground junction boxes. Arrange the splicing kit to minimize the effects of moisture.
- 5. Connect conductors No. 6 AWG and larger to panelboards and apparatus by means of approved mechanical lugs or compression connectors.
- 6. Do not use terminals on wiring devices to feed through to the next device.

3.2 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

- 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements. Test all wiring prior to energizing to ensure that it is free from unintentional grounds and shorts, is properly phased, and that all connectors are tight.

2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3. Certify compliance with test parameters.
- B. Test Reports: Prepare a written report to record the following:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.
- B. This Section includes:
 - 1. Grounding Conductors
 - 2. Connector Products
 - 3. Grounding Electrodes
 - 4. Ground Bars
 - 5. Miscellaneous Grounding Materials and Products

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Product data for the following products:
 - a. Electrodes, mechanical and compression connectors, and exothermic connectors .
- B. Qualification Data: For Contractor.
- C. Field Quality-Control Test Reports: From Contractor.
 - 1. Test procedures used.
 - 2. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Accurately record actual locations of all exterior buried electrodes Indicate dimensions from fixed structural elements.

1.3 DEFINITIONS

A. The following apply to this and other Sections of these Specifications:

1. EMT: Electrical metallic tubing.
2. ENT: Electrical nonmetallic tubing.
3. FMC: Flexible metal conduit.
4. IMC: Intermediate metal conduit.
5. LFMC: Liquidtight flexible metal conduit.
6. LFNC: Liquidtight flexible nonmetallic conduit.
7. RMC: Rigid Metal Conduit
8. GRS: Galvanized Rigid Steel Conduit
9. RAC: Rigid Aluminum Conduit
10. RNC: Rigid nonmetallic conduit.
11. PSF: Pounds per Square Foot

1.4 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Test Equipment Suitability and Calibration: Comply with NETA ATS (current version), "Suitability of Test Equipment" and "Test Instrument Calibration."
- C. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- D. Electrical Components, Devices, and Accessories:
1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 2. Marked for intended use.
 3. Comply with UL 467.

- E. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.
- F. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.
- G. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- B. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.2 GROUNDING CONDUCTORS, CONNECTORS, AND ELECTRODES:

- A. Manufacturers:
 - 1. Apache Grounding/Erico Inc.
 - 2. Boggs, Inc.
 - 3. Chance/Hubbell.
 - 4. Copperweld Corp.
 - 5. Dossert Corp.
 - 6. Erico Inc.; Electrical Products Group.
 - 7. FCI/Burndy Electrical.
 - 8. Galvan Industries, Inc.
 - 9. Harger Lightning Protection, Inc.
 - 10. Hastings Fiber Glass Products, Inc.
 - 11. Heary Brothers Lightning Protection Co.
 - 12. Ideal Industries, Inc.
 - 13. ILSCO.

14. Kearney/Cooper Power Systems.
15. Korns: C. C. Korns Co.; Division of Robroy Industries.
16. Lightning Master Corp.
17. Lyncole XIT Grounding.
18. O-Z/Gedney Co.; a business of the EGS Electrical Group.
19. Panduit, Inc
20. Racor, Inc.; Division of Hubbell.
21. Robbins Lightning, Inc.
22. Salisbury: W. H. Salisbury & Co.
23. Superior Grounding Systems, Inc.
24. Thomas & Betts, Electrical.

2.3 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section "Common Work Results for Electrical."
- B. Material: copper-clad aluminum, and copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Grounding Electrode Conductors: Bare, stranded, unless otherwise indicated.
- E. Underground Conductors: -Bare-copper conductor, No. 2/0 AWG minimum stranded, unless otherwise indicated.
- F. Bare Copper Conductors: Comply with the following:
 1. Solid Conductors: ASTM B 3.
 2. Assembly of Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.
- G. Copper Bonding Conductors: As follows:
 1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (wide and 1/16 inch thick).

H. Aluminum Bonding Conductors: As follows:

1. Not allowed.
- I. Grounding Bus: UL & cUL Listed to UL467 & C22.2 respectively, pre-drilled per TIA/EIA Standard 607, bare, 1/4 inch thick, electrolytic, tough pitch copper bar, length and width as indicated on the Drawings; insulators and standoffs as specified in Paragraph "Ground Bars" below.

2.4 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors
 1. Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM 8 1 87, essentially the same as the conductors being connected; clearly and permanently marked with the information listed below:
 - a. Company symbol and/or logo.
 - b. Catalog number.
 - c. Conductors accommodated.
 - d. Installation die index number or die catalog number is required.
 - e. Underwriters Laboratories "Listing Mark:".
 - f. The words "Suitable for Direct Burial" or, where space is limited, "Direct Burial" or "Burial" per UL Standard ANSI/UL467 (latest revision).
 2. Cast connectors: copper base alloy according to ASTM B 30 (latest revision).
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.5 GROUNDING ELECTRODES

- A. Ground Rods: UL-listed:
 1. Copper-clad steel; bonded copper electrolytically-applied to minimum thickness of 10 mils.
 2. Size: 5/8 inch by 8 feet . Provide sectional types when longer rods are indicated.

- B. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a bare conductor sized, at a minimum, for the size of the connecting grounding electrode conductor.
- C. Ground Plates: UL-listed, rectangular, bare solid copper plate; minimum 0.032-inch thick.

2.6 GROUND BARS

- A. Rectangular Ground Bars: UL & cUL Listed to UL467 & C22.2 respectively, pre-drilled per TIA/EIA Standard 607, bare, 1/4 inch thick, electrolytic, tough pitch copper bar, length minimum of 12" and width minimum 2" or as indicated on the Drawings for dimensions larger than minimum sizes.
- B. Supports: Minimum of two each 1-1/2-inch insulators and 1-inch stainless steel offset mounting brackets.

2.7 MISCELLANEOUS

- A. Test Wells:
 - 1. Traffic Areas: Polymer concrete reinforced with heavy weave fiberglass; H-20 load rating; minimum 24 inches deep.
 - 2. Non-traffic Areas: High density polyethylene; 350 PSF minimum load rating; minimum 10.25 inches deep.
- B. Ground Enhancing Backfill: Provide low-resistivity, ground-enhancing backfill material recommended by the electrode manufacturer.

PART 3 - EXECUTION

3.1 GENERAL

- A. Examine areas and conditions under which electrical grounding connections are to be made and notify the Architect/Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with Work until unsatisfactory conditions have been corrected.
- B. Provide all materials, labor and equipment for an electrical grounding system in accordance with applicable portions of the NEC and NECA. Coordinate electrical work as necessary to interface installation of electrical grounding systems with other work.
- C. Accomplish grounding and bonding of electrical installations and specific requirements for systems, circuits and equipment required to be grounded for both temporary and permanent construction.

3.2 APPLICATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

- B. In branch circuit and feeder raceways, use insulated equipment grounding conductors.
- C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated on the Drawings.
 - 1. Use insulated spacers and mounting brackets, and support from wall 8 feet above finished floor, unless otherwise indicated.
 - 2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the specified height above the floor.
- D. Underground Grounding Conductors: Bury at least 24 inches below grade, or 6 inches below the official frost line, whichever is greater, or when crossing a duct bank, bury 12 inches above duct bank.

3.3 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and branch circuits.
- C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs where allowed.
 - 7. Armored and metal-clad cable runs where allowed.
 - 8. Feeders and branch circuits installed in non-metallic raceways.
- D. Separately Derived Systems: Bond the derived neutral (grounded) conductor of all separately derived system (e.g., transformers, generators, UPS) to the nearest available grounding electrode, or back to the service grounding electrode if no approved electrodes are readily available. Size the grounding electrode conductor and bonding jumpers as indicated on the Drawings or as required by NFPA 70, whichever is larger.
- E. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panelboards or power-distribution units.
- F. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

- G. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.
- H. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components. On water heaters, bond metal hot and cold water pipes together, across the heater tank.
- I. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a ground bar. Size: 1/4-by-2-by-12-inches as indicated on Drawings.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- J. Metal Poles Supporting Outdoor Luminaires: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

3.4 COUNTERPOISE

- A. Ground the steel framework of the building with a buried electrode at the base of every corner column and at intermediate exterior columns at distances not more than 60 feet apart. Provide a grounding conductor (counterpoise), electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Use tinned-copper conductor not less than No. 2/0 AWG for counterpoise and for tap to building steel. Bury counterpoise not less than 18 inches below grade, or 6 inches below the official frost line, whichever is greater, and 24 inches from building foundation.

3.5 INSTALLATION

- A. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
 - 1. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
 - 2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
 - 3. Verify that final backfill and compaction has been completed before driving rod electrodes.
- B. Grounding Conductors: Where the size of the grounding conductors are not shown, size in accordance with NFPA 70 Rule along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

- C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
- E. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
- F. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
- G. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.
- H. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade, pavement, or floor.
- I. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare, tinned copper conductor not smaller than No. 4 AWG. If concrete foundation is less than 20 feet long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor above footer and foundation and connect to building structural steel or other grounding electrode external to concrete.

3.6 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Replace welds that are puffed up or that show convex surfaces indicating improper cleaning. Use exothermic welded connections for the following:
 - 1. Connecting conductors together.
 - 2. Connecting conductors to ground rods, except at test wells.
 - 3. Connecting conductors to building steel.
 - 4. Connecting conductors to plates.
- C. Compression Fittings: Permanent compression-type fittings may be used for the following rather than exothermic connections:
 - 1. Connecting conductors together.
 - 2. Connecting conductors to building steel.
 - 3. Connecting conductors to ground rods, except at test wells.
- D. Mechanical Pressure Fittings: Use bolted mechanical (removable) pressure-type clamps for the following:
 - 1. Connecting conductors to ground rods at test wells.
 - 2. Connecting conductors to pipes.
- E. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- F. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- G. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.
- H. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- I. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- J. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.7 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

- A. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- B. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 6 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- C. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise encircling the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade, or 6 inches below the official frost line, whichever is greater, and 6 inches from the foundation.

3.8 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 - 1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
 - 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
 - 3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
 - 4. Test Values:
 - a. The resistance between the main grounding electrode and earth ground shall be no greater than 10 ohms.
 - b. Equipment Rated 500 kVA and Less: 10 ohms.
 - c. Equipment Rated 500 to 1000 kVA: 5 ohms.

- d. Equipment Rated More Than 1000 kVA: 3 ohms.
 - e. Substations and Pad-Mounted Switching Equipment: 5 ohms.
 - f. Manhole Grounds: 10 ohms.
- 5. Perform point-to-point megohmmeter tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
 - 6. Minimum system neutral-to-ground insulation resistance: one megohm.
 - 7. Investigate point-to-point resistance values that exceed 0.5 ohms.
 - a. Check for loose connections.
 - b. Check for absent or broken connections.
 - c. Check for poor quality welds.
 - d. Consider other reasons.
 - 8. Excessive Grounding Electrode Resistance: If measured resistance to earth ground value exceeds specified values, add grounding electrodes and additional conductors as required to obtain the specified value.

3.9 GRADING AND PLANTING

- A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 31 and 32. Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.2 DEFINITIONS

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

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Nonmetallic slotted support systems.
- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.6 COORDINATION

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

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 5. Channel Dimensions: Selected for applicable load criteria.

- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.
 2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
 4. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.

- 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

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

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Bolt to concrete inserts.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Existing Concrete: Expansion anchor fasteners.

5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.

6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.

7. To Light Steel: Sheet metal screws.

8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

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

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. This Section includes:
 - 1. Raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Division 26/27 Section “Common Work Results for Communications”.

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.
- B. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section “General Electrical Requirements”:
 - 1. Accurately record actual routing of all exterior buried raceway and all interior raceways three inches and larger. Indicate dimensions from fixed structural elements.
- C. Samples for Initial Selection: For wireways, nonmetallic wireways, and surface raceways with factory-applied texture and finishes.
- D. Samples for verification: For each type of exposed finish required for wireways, nonmetallic wireways, and surface raceways, prepared on Samples of size indicated below.
- E. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members in path of conduit groups with supports.
 - 2. HVAC items, plumbing items and architectural features in the paths of conduit groups with common supports.

1.3 DEFINITIONS

- A. Terminology used in this specification is as defined below:
 - 1. EMT: Electrical Metallic Tubing
 - 2. FMC: Flexible Metal Conduit
 - 3. GRS: Galvanized Rigid Steel Conduit

4. IMC: Intermediate Metal Conduit
5. LFMC: Liquidtight Flexible Metal Conduit
6. LFNC: Liquidtight Flexible Nonmetallic Conduit
7. RAC: Rigid Aluminum Conduit
8. RMC: Rigid Metal Conduit
9. RNC: Rigid Nonmetallic Conduit

1.4 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Electrical Components, Devices, and Accessories:
 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
 2. Marked for intended use.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- B. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.2 CONDUITS, SURFACE MOUNTED RACEWAYS AND ACCESSORIES

- A. Metal Conduit And Tubing
 1. Manufacturers:
 - a. AFC Cable Systems, Inc.
 - b. Alfex Corporation, a Southwire Company

- c. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - d. Electri-Flex Co.
 - e. Indalex
 - f. Manhattan/CDT/Cole-Flex
 - g. O-Z/Gedney; Unit of General Signal (Fittings)
 - h. Republic Raceway
 - i. Tyco International; Allied Tube & Conduit Div.
 - j. Western Tube and Conduit Corporation
 - k. Wheatland Tube Co.
2. RMC:
- a. GRS: Hot-dip galvanized: ANSI C80.1, UL 6.
 - b. RAC: ANSI C80.5, UL6A.
3. IMC: ANSI C80.6, UL 1242.
4. Plastic-Coated GRS and Fittings: NEMA RN 1, UL-listed. Coating thickness of 0.04 inches (1mm), minimum.
5. Plastic-Coated IMC and Fittings: NEMA RN 1, UL-listed.
6. EMT and Fittings: ANSI C80.3, UL 797.
- a. Fittings: Set-screw type.
7. FMC: Aluminum: UL 1.
8. LFMC: Flexible steel raceway with PVC jacket: UL 360.
- a. Fittings: NEMA FB 1; compatible with raceway and tubing materials.
- B. Nonmetallic Raceway
1. Manufacturers:
- a. AFC Cable Systems, Inc. (Tubing)
 - b. American International.
 - c. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - d. Arnco Corp.

- e. Cantex Inc.
 - f. Certainteed Corp.; Pipe & Plastics Group.
 - g. Condux International.
 - h. ElecSYS, Inc.
 - i. Electri-Flex Co.
 - j. Lamson & Sessions; Carlon Electrical Products.
 - k. Manhattan/CDT/Cole-Flex.
 - l. Prime Conduit (formerly Carlon)
 - m. RACO; Division of Hubbell, Inc.
 - n. Spiraldut, Inc./AFC Cable Systems, Inc.
 - o. Superflex Ltd.
 - p. Thomas & Betts Corporation.
2. RNC: Schedule 40 PVC: NEMA TC 2, UL 651.
- a. Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.
- C. Metal Wireways
- 1. Manufacturers:
 - a. Cooper B-Line
 - b. EPI-Electrical Enclosures
 - c. Hoffman.
 - d. Square D.
 - 2. Material and Construction: 14 gauge (minimum) sheet steel, sized and shaped as indicated, NEMA type, as required for installed location.
 - 3. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70. Where indicated, provide a barrier to divide wireway into compartments.
 - 4. Wireway Covers: Hinged type.

5. Finish: Manufacturer's standard phosphate pre-treatment and baked enamel finish.

D. Nonmetallic Wireways

1. Available Manufacturers:
 - a. Enduro Composite Systems
 - b. Hoffman.
 - c. Lamson & Sessions; Carlon Electrical Products.
2. Description: Fiberglass reinforced polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Gasketed cover with oil-resistant gasket material and fastened with corrosion resistance captive screws or with snap-on covers and cover splice plates; flanged connections, with stainless-steel screws and oil-resistant gaskets.
3. Description: PVC, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
4. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
5. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Surface Metal Raceways

1. Manufacturers:
 - a. Wiremold/LeGrand.
 - b. Mono-Systems, Inc.
 - c. Panduit Corp
2. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
3. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

F. Surface Nonmetallic Raceways

1. Manufacturers:
 - a. Butler Manufacturing Co.; Walker Division.
 - b. Enduro Composite Systems.
 - c. Hubbell, Inc.; Wiring Device Division.

- d. Lamson & Sessions; Carlon Electrical Products.
 - e. Panduit Corp.
 - f. Mono-Systems, Inc.
 - g. Wiremold/Legrand
- 2. Two-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color.
 - 3. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.3 BOXES, ENCLOSURES AND CABINETS

A. General

- 1. Manufacturers:
 - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - b. Emerson/General Signal; Appleton Electric Company.
 - c. Erickson Electrical Equipment Co.
 - d. Hoffman.
 - e. Hubbell, Inc.
 - f. Killark Electric Manufacturing Co.
 - g. O-Z/Gedney; Unit of General Signal.
 - h. RACO; Division of Hubbell, Inc.
 - i. Robroy Industries, Inc.; Enclosure Division.
 - j. Scott Fetzer Co.; Adalet-PLM Division.
 - k. Spring City Electrical Manufacturing Co.
 - l. Thomas & Betts Corporation.
 - m. Walker Systems, Inc.; Wiremold Company (The).
 - n. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary

B. Outlet Boxes

- 1. Sheet Metal Outlet and Device Boxes: NEMA OS 1; UL514A.

2. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
3. Nonmetallic Outlet and Device Boxes: NEMA OS 2
4. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified in the following paragraphs. Manufacturers and model numbers listed are used only to represent the characteristics required and are not intended to restrict the use of other Manufacturers listed above and models that meet the specified criteria.
 - a. Boxes for exposed work: deep drawn type with raised covers:
 - 1) Appleton 4S 1/2-DR; 8300 series cover.
 - 2) RACO 190 series; 800 series cover.
 - 3) Steel City 52150 series; RS series cover.
 - b. Concealed and exposed boxes for lighting:
 - 1) Appleton 40-3/4.
 - 2) RACO 160 series.
 - 3) Steel City 54170 series.
 - c. Boxes imbedded in concrete for lighting:
 - 1) Appleton OCR
 - 2) RACO 270 or 280 series.
 - 3) Steel City 54500 series.
 - d. Boxes for flush switches, receptacles, or other general devices:
 - 1) Appleton 4SVB series; 8400 series cover.
 - 2) RACO 198 series; 770 series cover.
 - 3) Steel City CWV series; 52-C-00 series cover.
 - e. Boxes for flush switches, receptacles, or other general devices installed in masonry construction:
 - 1) Appleton MI-250 series or MI-350 series.
 - 2) RACO 690 series or 960 series.
 - 3) Steel City GW series.

- f. Boxes for telephone, data, telecommunications and audio-video outlets, refer to Division 27 Section "Common Work Results for Communications".
- g. Exposed weatherproof boxes for general devices: cast aluminum with mounting lugs and neoprene gasket:
 - 1) Appleton FDB series.
 - 2) RACO 5300 series.
 - 3) Steel City T100L or LT100L series.
- h. Exposed weatherproof boxes for general devices: cast aluminum with neoprene gasket:
 - 1) Appleton FS series.
 - 2) RACO 5300 series.
 - 3) Steel City T100 or LT100 series.

C. Junction and Pull Boxes

- 1. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- 2. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast iron with gasketed cover.

D. Cabinets and Enclosures

- 1. General:
 - a. Compliance: NEMA 250; UL 50 and 508A, as applicable.
 - b. NEMA Type 1: Code-gauge phosphatized steel with continuously welded seams; manufacturer's standard ANSI 61 gray polyester powder finish inside and out; non-gasketed removable hinged front cover, with flush latch and concealed hinge; collar studs.
 - c. NEMA Type 3R: Code-gauge galvanized steel with drip shield top, seam-free front, side, and back; manufacturer's standard ANSI 61 gray polyester powder finish inside and out; non-gasketed continuous-hinged door, with stainless steel pin; captive, plated steel cover screws; hasp and staple for padlocking; collar studs.
 - d. NEMA Type 4X: External wall-mounting brackets; rolled flanges on door and door opening; continuous-hinged door, with removable stainless steel pin; seamless continuous gasket; stainless steel hasp and staple for padlocking; collar studs; captive, stainless steel door clamps on 3 sides of door; interior data pocket:
 - 1) Metal: Code-gauge Type 304 stainless steel with continuously welded seams.
 - e. Removable painted steel interior panel mounted on standoffs; metal barriers to separate wiring of different systems and voltages.

- f. Where keyed locks are indicated, provide 2 keys for each enclosure, with all locks keyed alike.
- g. Provide enclosures wider than 36 inches with double doors; removable center posts; internal bracing, supports, or both, as required to maintain their structural integrity; and, accessory feet where required for freestanding equipment.
- h. Provide clamps, grids, slotted wireways, or similar devices to which or by which wiring may be secured. Provide DIN-rail mounted terminal strips for terminating all incoming and outgoing control wiring, and power terminal blocks for incoming/outgoing power wiring.
- i. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power and higher-voltage control wiring.

2.4 FACTORY FINISHES

- A. Finish: For metal wireway and surface raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: For metal wireway and surface raceway, enclosure, or cabinet components, provide manufacturer's standard paint applied to factory-assembled metal wireway and surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.1 RACEWAYS

A. General

- 1. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this article are stricter.
- 2. Provide sizes and types of raceways as indicated on the Drawings. Sizes are based on THWN insulated copper conductors, except where noted otherwise. Where sizes are not shown on the Drawings or in the Specifications, size raceways in accordance with NFPA 70 requirements for the number, size and type of conductors installed. Minimum raceway size: 1/2 inch (concealed and exposed); 1 inch (underground and under slab).
- 3. Provide all raceways, fittings, supports, and miscellaneous hardware required for a complete electrical system as described by the Drawings and Specifications.
- 4. Install a green-insulated, equipment-grounding conductor, which is bonded to the electrical system ground, in all raceways, with the exception of Service Entrance raceways.
- 5. Install grounding bushings on all conduit terminations and bond to the enclosure, equipment grounding conductor, and electrical system ground.

6. Install raceways concealed in walls or above suspended ceilings in finished areas. When approved by the Architect, raceways may be installed concealed in elevated floor slabs. Do not install raceways horizontally within slabs on grade.
7. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
8. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
9. Make bends and offsets so inside diameters are not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
10. Install raceways:
 - a. To meet the requirements of the structure and the requirements of all other Work on the Project.
 - b. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.
 - c. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Architect.
 - d. Parallel or perpendicular to building lines or column lines.
 - e. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
11. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover.
 - a. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - b. Space raceways laterally to prevent voids in concrete.
 - c. 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.
 - d. Change from RNC to coated GRS or IMC before rising above the floor.
12. Where masonry walls are left unfinished, coordinate raceway installations with other trades so that the raceways and boxes are concealed and the wall will have a neat and smooth appearance.
13. Support raceways from structural elements of the building as required by NFPA 70, Division 26 Section "Hangers and Supports for Electrical Systems". Do not support raceways by hangers used for any other systems foreign to the electrical systems; and, do not attach to other foreign systems. Do not lay raceways on top of the ceiling system.

14. Provide support spacing in accordance with NFPA 70 requirements, and at a minimum in accordance with NEMA standards. Support by the following methods:
 - a. Attach single raceway directly to structural steel with beam clamps.
 - b. Attach single raceway directly to concrete with one-hole clamps or clips and anchors. Outdoors and wherever subject to dampness or moisture, offset raceways from the surface by using galvanized clamps and clamp backs, to mitigate moisture entrapment between raceways and surfaces.
 - c. Attach groups of raceway to structural steel with slotted support system attached with beam clamps. Attach raceway to slotted channel with approved raceway clamps.
 - d. Attach groups of raceway to concrete with cast-in-place steel slotted channel fabricated specifically for concrete embedment. Attach raceway to steel slotted channel with approved raceway clamps.
 - e. Hang plumb horizontally suspended single raceway using a threaded rod. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to threaded rod with approved raceway clamps.
 - f. Hang horizontally suspended groups of raceway using steel slotted support system suspended from threaded rods. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to steel slotted channel with approved raceway clamps.
 - g. Support conductors in vertical raceway in accordance with NFPA 70 requirements.
 - h. Cross-brace suspended raceway to prevent lateral movement during seismic activity.
 - i. Use pre-fabricated non-metallic spacers for parallel runs of underground or under-slab conduits, either direct buried or encased in concrete.
15. Install electrically- and physically-continuous raceways between connections to outlets, boxes, panelboards, cabinets, and other electrical equipment with a minimum possible number of bends and not more than the equivalent of four 90-degree bends between boxes. Make bends smooth and even, without flattening raceway or flaking the finish.
16. Protect all electrical Work against damage during construction. Repair all Work damaged or moved out of line after rough-in, to meet the Architect's approval, without additional cost to the Owner. Cover or temporarily plug openings in boxes or raceways to keep raceways clean during construction. Clean all raceways prior to pulling conductors or cables.
17. Align and install raceway terminations true and plumb.
18. Complete raceway installation before starting conductor installation.
19. Install a pull cord in each empty raceway that is left empty for installation of wires or cables by other trades or under separate contracts. 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 cord.

20. Install approved expansion/deflection fittings where raceways pass through or over building expansion joints.
21. Route raceway through roof openings for piping and ductwork or through roof seals approved by the Architect, the roofing contractor, or both. Obtain approval for all roof penetrations and seal types from the Architect, Owner, roofing contractor, or all three as required to maintain new or existing roofing warranties.
22. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces or from building exterior to building interior.
 - b. Where otherwise required by NFPA 70.
23. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with GRS; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

B. RMC

1. Use GRS in the following areas:
 - a. Where indicated.
 - b. Exterior applications where above grade and exposed.
 - c. Below grade when concrete-encased, plastic-coated, or provided with a corrosion resistant approved mastic coating.
 - d. All raceways penetrating slabs on grade (use plastic-coated raceway or provide with a corrosion resistant approved mastic coating). This shall include the 90-degree elbow below grade and the entire vertical transition to above grade.

C. EMT

1. Use EMT in the following areas:
 - a. Where indicated.
 - b. Interior concealed locations for:
 - 1) Branch and feeder circuits.
 - 2) Low-voltage control, security, and fire alarm circuits
2. Do not use EMT:

- a. Below grade.
- b. In exterior applications when exposed.

D. FMC and LFMC

- 1. Use FMC or LFMC:
 - a. For the final 24 inches of raceway to all motors, transformers, and other equipment subject to vibration or movement.
 - b. From outlet boxes (attached to building structure) to recessed light fixtures. Install sufficient length to allow for relocating each light fixture within a 5-foot radius of its installed location.
- 2. Do not use FMC or LFMC:
 - a. For branch circuits, homeruns or feeders.
 - b. In lengths exceeding 6 feet.
- 3. Use FMC only in dry locations; use LFMC in damp, wet, corrosive, and outdoor locations, and food service and kitchen areas.

E. RNC

- 1. Solvent-weld RNC fittings and raceway couplings per the manufacturer's instructions and make all connections watertight. Use solvent of the same manufacturer as the raceway.
- 2. Where installed exposed outdoors or other areas subject to temperature variations, install expansion fittings per Article 352.44 of NFPA 70, to accommodate thermal expansion in straight runs.
- 3. Use RNC in the following locations:
 - a. Only where specifically indicated, and then only as specified below.
 - b. Underground, single and grouped, in lieu of GRS or IMC, when indicated.
 - 1) Direct buried
 - 2) Concrete-encased (use approved rigid PVC interlocking spacers, selected to provide minimum duct spacing and cover depths indicated while supporting ducts during concreting and backfilling; produced by the same manufacturer as the ducts).
- 4. Do not use RNC:
 - a. Exposed indoors
 - b. In occupied spaces.
 - c. In return air plenums.

- d. Where subject to physical damage.
- e. Where not permitted by codes.

F. Raceway Fittings: Compatible with raceways and suitable for use and location.

- 1. RMC and IMC: Use threaded rigid steel conduit fittings, unless otherwise indicated.
- 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings and installation tools approved by the manufacturer for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits. Replace all fittings and conduits that have any portion of the coating scraped off to bare metal, at no additional cost to the Owner.
- 3. Join raceways with fittings designed and approved for that purpose and make joints tight.
- 4. Use insulating bushings to protect conductors at raceway terminations:
 - a. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 - b. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

G. Telephone and Signal/Data System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

H. Wireways

- 1. Use flat head screws, clips and straps to fasten wireways to surfaces. Mount plumb and level.
- 2. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- 3. Close ends of wireway and unused raceway openings.

I. Surface Raceways

- 1. Use flat head screws, clips and straps to fasten surface raceways to surfaces. Mount plumb and level.
- 2. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- 3. Close ends of surface raceway.

3.2 BOXES

A. General

1. Verify locations of device boxes prior to rough in.
2. Set boxes at elevations to accommodate mounting heights as specified or indicated on the Drawings.
3. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Adjust box locations to accommodate intended purpose.
4. Install boxes to preserve fire ratings of walls, floors, and ceilings.
5. Install flush wall-mounted boxes without damaging wall insulation or reducing its effectiveness.
6. Support boxes independently of raceway.
7. Clean the interior of boxes to remove dust, debris, and other material. Clean exposed surfaces and restore finish.
8. Adjust flush-mounted boxes to make front edges flush with finished wall material.
9. Provide boxes of the depth required for the service, device and the application, and with raised covers set flush with the finished wall surface for boxes concealed in plaster finishes. Select covers with the proper openings for the devices being installed in the boxes. Install boxes flush unless otherwise indicated.
10. Install outlet boxes in firewalls complying with UL requirements, with box surface area not exceeding 16 square inches; and, when installed on opposite sides of the wall, separate by a distance of at least 24 inches.

B. Outlet Boxes

1. Install all electrical devices, such as plug receptacles, lamp receptacles, light switches, and light fixtures in or on outlet boxes.
2. Locations of outlets on Drawings are approximate; and, except where dimensions are shown, determine exact dimensions for locations of outlets from plans, details, sections, or elevations on Drawings, or as directed by Architect. Locate outlets generally from column centers and finish wall lines or to centers or joints of wall or ceiling panels.
3. Locate outlet boxes so they are not placed back-to-back in the same wall, and in metal stud walls, so they are separated by at least one stud space, to limit sound transmission from room to room. Install outlet boxes in accessible locations and do not install outlets above ducts or behind furring.
4. Install extension and plaster rings as required by NFPA 70.
5. Carefully set outlet boxes concealed in non-plastered block walls so as to line up with wall joints. Coordinate the box and raceway installation with the wall construction as required for a flush and neat appearing installation. Outlet box extensions may be used where necessary.
6. Do not exceed allowable fill per NFPA 70.
7. Where multiple devices are shown grouped together, gang mount with a common cover plate.

C. Junction and Pull Boxes

1. Install junction and pull boxes above accessible ceilings and in unfinished areas.
2. Provide boxes set flush in painted walls or ceilings with primer coated cover.
3. Where junction and pull boxes are installed above an inaccessible ceiling, locate so as to be easily accessible from a ceiling access panel.
4. Boxes for exterior use shall be:
 - a. PVC with a UV-stabilized PVC cover sealed and gasketed watertight.
 - b. Cast aluminum with a cast aluminum cover sealed and gasketed watertight.
 - c. Cast iron with cast iron cover sealed and gasketed watertight in vehicular traffic areas. Provide box and cover UL listed for use in vehicular traffic areas.
 - d. Install buried boxes so that box covers are flush with grade, unless indicated otherwise.

3.3 CABINETS AND ENCLOSURES

- A. Unless otherwise indicated on the Drawings, provide NEMA 1 construction for indoor, dry locations; NEMA 12 for indoor, damp and dusty locations; NEMA 3R for outdoor locations; NEMA 4X for indoor wet and corrosive locations.
- B. Install flush mounted in the wall in finished spaces, with the top 78 inches above finished floor. The front shall be approximately 3/4-inch larger than the box all around.
- C. Install surface mounted in unfinished spaces, with the top 78 inches above finished floor. The front shall be the same height and width as the box.
- D. Electrically ground all metallic cabinets and enclosures. Where wiring to cabinet or enclosure includes a grounding conductor, provide a grounding lug in the interior of the cabinet or enclosure. Cabinets and enclosures specified in this Section are intended to house miscellaneous electrical components assembled in a custom arrangement, such as contactors and relays.
- E. All components that are specified or indicated for assembly in cabinets and enclosures shall each be individually UL listed and labeled. Arrange wiring so that it can be readily identified. Support wiring no less than every 3 inches. Install gauges, meters, pilot lights and controls on the face of the door.
- F. Do not provide cabinets and enclosures smaller than the sizes indicated. Where sizes and types are not indicated, provide cabinets and enclosures of the size, type and classes appropriate for the use and location per the guidelines of the NEC. Provide all items complete with covers and accessories required for the intended use.

END OF SECTION

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes:

1. Raceways, fittings, boxes, and handholes.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":

1. Product data for the following products:

- a. Raceways, Raceway fittings, separators, duct-bank materials, manholes, handholes, boxes, solvent cement, warning tape and warning planks.

2. Shop drawings for:

- a. Detailing fabrication and installation for custom manholes or handholes including duct entry provisions, reinforcing details, frame and cover design, manhole frame support rings, ladder details, grounding details, sump details, joint details, and cable racks, pulling irons, lifting irons.

B. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":

1. Accurately record actual routing of all exterior buried raceway including coordination with other surrounding utilities and underground structures. Provide scaled plans and sections that indicate dimensions from finished grade or other fixed structural elements.

1.3 DEFINITIONS

A. Terminology used in this specification is as defined below:

1. GRS: Galvanized Rigid Steel Conduit
2. RMC: Rigid Metal Conduit
3. RNC: Rigid Nonmetallic Conduit

1.4 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
 - 2. Marked for intended use.
- C. Comply with NFPA 70 and ANSI C2.
- D. Test and inspect pre-cast concrete utility structures according to ASTM C 1037.
- E. Non-concrete Handhold and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by a independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 PROJECT CONDITIONS

- A. Interruption of existing electrical service to occupied facilities shall not occur unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated.
 - 1. Notify Architect no fewer than two days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Architects written permission.

1.7 COORDINATION

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

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

- A. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.2 RACEWAYS AND FITTINGS

A. Metal Conduit

1. Manufacturers:

- a. AFC Cable Systems, Inc.
- b. Alfex Corporation, a Southwire Company
- c. Anamet Electrical, Inc.; Anaconda Metal Hose.
- d. Electri-Flex Co.
- e. Indalex
- f. Manhattan/CDT/Cole-Flex
- g. O-Z/Gedney; Unit of General Signal (Fittings)
- h. Republic Raceway
- i. Tyco International; Allied Tube & Conduit Div.
- j. Wheatland Tube Co.

2. RMC:

- a. GRS: Hot-dip galvanized: ANSI C80.1, UL 6

3. Plastic-Coated GRS and Fittings: NEMA RN 1, UL-listed. Coating thickness of 0.40 inches (1 mm), minimum.
 4. Fittings: NEMA FB 1; compatible with raceway and tubing materials.
- B. Nonmetallic Raceway
1. Manufacturers:
 - a. AFC Cable Systems, Inc. (Tubing)
 - b. American International.
 - c. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - d. Arnco Corp.
 - e. Cantex Inc.
 - f. Certainteed Corp.; Pipe & Plastics Group.
 - g. Condux International.
 - h. ElecSYS, Inc.
 - i. Electri-Flex Co.
 - j. Lamson & Sessions; Carlon Electrical Products.
 - k. Manhattan/CDT/Cole-Flex.
 - l. RACO; Division of Hubbell, Inc.
 - m. Spiralduct, Inc./AFC Cable Systems, Inc.
 - n. Superflex Ltd.
 - o. Thomas & Betts Corporation.
 2. RNC: Schedule 40 (type EPC-40-PVC) and 80 (type EPC-80-PVC) PVC: NEMA TC 2, UL 651.
 - a. Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.
- C. DUCT ACCESSORIES
1. Duct Separators shall be factory-fabricated rigid interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.

2. Underground-line warning tape specified in Division 26 Section “Identification for Electrical Systems.”
3. Concrete warning planks shall be nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.
 - a. Color: Red dye added to concrete during batching.
 - b. Labeling: Mark each plank with “ELECTRICAL” in 2-inch high, 3/8-inch deep letters.

2.3 PRE-CAST CONCRETE HANDHOLES AND BOXES

A. General

1. Manufacturers:
 - a. Carder Concrete Products.
 - b. Christy Concrete Products
 - c. Elmhurst-Chicago Stone Co.
 - d. Oldcastle Pre-cast Group
 - e. Riverton Concrete Products; a division of Cretex Companies, Inc.
 - f. Utility Concrete Products, LLC
 - g. Utility Vault Co.
 - h. Wausau Title, Inc.

B. Comply with ASTM C858 for design and manufacturing process.

C. Pre-cast concrete handholes and boxes shall be factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of the handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. The cover finish shall be a nonskid finish with a minimum coefficient of friction of 0.50.
3. The cover shall have the following legend lettering molded into the cover:
 - a. “C.A.T.V.”
 - b. “COMMUNICATIONS”
 - c. “CONTROLS”

- d. "ELECTRICAL"
 - e. FIBER OPTICS"
 - f. "LIGHTING"
- 4. Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
 - 5. Extensions and slabs shall be designed to mate with bottom of enclosure and shall be same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches.
 - b. Slab shall be same dimensions as bottom of enclosure, and arranged to provide closure.
 - 6. Duct entrances into handhole walls shall have cast end-bell or duct-terminating fittings in the wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
 - 7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Feeders 600 volts and Less: RNC, NEMA Type EPC-80 PVC, in direct- buried duct bank, unless otherwise indicated.
- B. Underground Ducts Crossing Driveways and Roadways: RNC, NEMA Type EPC-40 PVC, encased in reinforced concrete.

3.2 UNDERGROUND ENCLOSURE INSTALLATION

- A. Handholes and Boxes for 600 volts and Less:
 - 1. Units in roadways and Other Deliberate Traffic Paths: Pre-cast concrete. AASHTO HB 17, H-10 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Pre-cast Concrete, AASHTO HB 17, H-20] [Polymer Concrete, SCTE 77, Tier 15] [Fiberglass Enclosures with Polymer Concrete Frame and Cover, SCTE 77, Tier 15] [Fiberglass-reinforced Polyester Resin, SCTE 77, Tier 15] [High-density Plastic, SCTE 77, Tier 15] structural load rating.

3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate loading by Vehicles: Pre-cast Concrete, AASHTO HB 17, H-10 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced Polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

3.3 EARTHWORK

- A. Excavation and Backfilling: Comply with Division 31 Section "Earth Moving" but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling and compaction is complete.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants"
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.4 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48-inches, both horizontally and vertically, at other locations, unless otherwise indicated.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- D. Duct Entrances to Handholes: Use end bells, spaced approximately 10-inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit

penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."

- F. Sealing: Provide temporary closure at termination of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- G. Pulling Cord: Install 100-lbf test nylon cord in ducts, including spares.
- H. Direct-Buried Duct Banks:
 - 1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 - 2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6-inches between tiers.
 - 3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6-inches in nominal diameter.
 - 4. Install backfill as specified in Division 31 Section "Earth Moving."
 - 5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4-inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
 - 6. Install ducts with a minimum of 3-inches between ducts for like services and 6-inches between power and signal ducts.
 - 7. Depth: Install top of duct bank at least 36-inches below finished grade, unless otherwise indicated.
 - 8. Set elevation of bottom of duct bank below the frost line.
 - 9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3-inches of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60-inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 10. Warning Planks: Bury warning planks approximately 12 inches above all direct-buried ducts and duct banks placing them 24-inches O.C.. Align planks along the width and along the centerline of

duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18-inches. Space additional planks 12-inches apart, horizontally.

3.5 INSTALLATION OF CONCRETE HANDHOLES

A. Precast Concrete Handhole Installation:

1. Comply with ASTM C891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

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

3.6 GROUNDING

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

END OF SECTION

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This Section includes the following:
 - 1. Nameplates
 - 2. Labels for raceways and metal-clad cable.
 - 3. Labels for junction boxes and pull boxes.
 - 4. Labels for wiring devices and lighting control devices.
 - 5. Markers for conductors, and control cables.
 - 6. Tags.
 - 7. Underground-line warning tape.
 - 8. Warning labels and signs.
 - 9. Arc Flash Warning Labels.
 - 10. Instruction signs.
 - 11. Miscellaneous identification products.
 - 12. .

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Where a facility identification standard already exists, that standard shall be continued. Where an identification standard does not exist, color-coding and identification shall be as described herein.
- B. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- C. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- D. Coordinate installation of identifying devices with location of access panels and doors.

- E. Install identifying devices before installing acoustical ceilings and similar concealment.

1.3 SUBMITTALS

- A. Product Data: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements” for each electrical identification product indicated:
 - 1. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
 - 2. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7 and that are acceptable to authorities having jurisdiction.
 - 2. Marked for intended use.
- B. Comply with ANSI A13.1 and ANSI C2.
- C. Comply with NFPA 70.
- D. Comply with 29 CFR 1910.145.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

- A. Location, text, and method of identification to be used is noted in individual sections. Refer to related sections for additional identification requirements.

2.2 NAMEPLATES

- A. Engraved, Laminated Acrylic or Melamine Label, adhesive backed. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high. For elevated components, increase sizes of labels and letters to those appropriate for viewing from the floor.
 - 1. Normal systems - white letters on a black background.

2.3 LABELS FOR RACEWAYS AND METAL-CLAD CABLE

- A. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.4 LABELS FOR JUNCTION BOXES AND PULL BOXES

- A. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.

2.5 LABELS FOR WIRING DEVICES AND LIGHTING CONTROL DEVICES

- A. Self-laminating Computer Printable Labels: Clear over-laminate to protect legend for permanent, clean identification. Self-laminating Polyester material with white print-on area.

2.6 MARKERS FOR CONDUCTOR AND CONTROL CABLES

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Self-laminating Computer Printable Labels: Clear over-laminate to protect legend for permanent, clean identification. Self-laminating Polyester material with white print-on area.

2.7 TAGS

- A. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.8 UNDERGROUND-LINE WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 - 1. Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.

4. Printed legend shall indicate type of underground line.

2.9 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145. Attachment method shall be acceptable to the manufacturers of the equipment to which the nameplates are being applied and shall not compromise any NRTL listing or labeling criteria.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).
- E. Warning label and sign shall include, but are not limited to, the following legends:
 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 2. Workspace Clearance Warning (208 Volts): "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
 3. Workspace Clearance Warning (480 Volts): "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 48 INCHES (915 MM)."

2.10 ARC FLASH WARNING LABELS

- A. 3.5 in. x 5 in., unless otherwise noted by Owner, thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. All labels will be based on recommended overcurrent device settings and will be printed after the results of the analysis have been presented and after any system changes, upgrades, or modifications have been incorporated in the system.
- C. The label shall include the following information, at a minimum:
 1. Location designation
 2. Nominal voltage
 3. Available fault current

4. Flash protection boundary
 5. Hazard risk category
 6. Incident energy
 7. Working distance
 8. Engineering report number, revision number and issue date.
- D. Labels shall be machine printed, with no field markings.

2.11 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes. Unless indicated otherwise, provide with minimum 3/8-inch- (10-mm-) high letters.
1. Punched or drilled for mechanical fasteners.
 2. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
 3. Normal systems: Engraved legend with white letters on black face.

2.12 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength: 50 lb (22.6 kg), minimum.
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black, except where used for color-coding.
- B. Fasteners for Nameplates, Labels and Signs
1. Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat lock washers unless otherwise noted.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify identity of each item before installing identification products.

- B. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. For surfaces that require finish work, apply identification devices after completing finish work.
- C. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- D. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- E. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
- F. Equipment Nameplates and Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual

END OF SECTION

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies, and the setting of these devices.
 - 1. Also include coordination of series-rated devices where series rating is specified in other sections and where indicated on Drawings.
 - 2. The AIC ratings indicated on the Drawings are preliminary and will be finalized based on the results of the fault current study. Device ratings for furnished equipment shall be as required by the results of the fault current study at no additional cost.
- B. Study must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If study has not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project.

1.2 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. Coordination-study report.
 - 3. Equipment evaluation report.
 - 4. Arc-Flash Hazard Analysis.
 - 5. Setting report.
- E. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":

1. Accurately record on the One-Line Diagram actual ratings and settings for all overcurrent devices, both adjustable and non-adjustable, including all changes made during construction, due to the study, or both.
- F. Electronic files, in an SKM-compatible format, of the time-current characteristic curves for every different overcurrent device used in the reports.

1.3 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.
 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 399 for general study procedures.
- D. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- E. Comply with IEEE 1584 and NFPA 70E for arc-flash hazard calculations.

PART 2 - PRODUCTS AND MATERIALS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Computer Software Developers: Subject to compliance with requirements, provide computer software programs developed by one of the following:
 1. CYME International, Inc.
 2. EDSA Micro Corporation.
 3. Electrical Systems Analysis, Inc.
 4. SKM Systems Analysis, Inc.
 5. Operation Technology, 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. Zero-Sequence current.
 - 2. Arcing faults.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
- 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.
- C. Fault current study and coordination study to be performed prior to the final submittals for any piece of electrical equipment which has an AIC rating or an over-current protective device so that correct equipment gets ordered for the project conditions.
- D. Arc Flash Study must be performed after conductors and equipment have been installed and after the project's utility company confirms the available fault current. A final coordination study with all device settings shall be submitted with the Arc Flash Study. The goal of the revised settings is to minimize the arc flash hazard while maintaining reasonable coordination and selectivity. For the components of emergency and legally required standby system components, full selectivity must be maintained.

3.2 SYSTEM COMPONENTS TO BE INCLUDED IN STUDIES

- A. Study shall begin with the utility and each alternate power source overcurrent device(s) serving the Project and end at the last branch circuit overcurrent protective device. This includes studies of the complete paths on both sides of any transfer switch, contactor or circuit breaker.
- B. Components include, but are not limited to:
 - 1. Switchboards
 - 2. Distribution Panelboards
 - 3. Panelboards
 - 4. Chiller Controllers

5. Air Handling Equipment
6. Roof Top HVAC equipment
7. Elevator controllers

3.3 POWER SYSTEM DATA FOR STUDIES

A. Gather and tabulate the following input data to support studies:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical distribution system diagram 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. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.
 - e. 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 ratings in amperes rms symmetrical.

3.4 FAULT-CURRENT STUDY

- A. Source Impedance: Utility company's fault-current contribution as indicated, and confirmed with documentation from utility.
- 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. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.
- E. 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.
- F. Study Report:
 - 1. Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report.
 - 2. 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.
- G. 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.

3.5 COORDINATION STUDY

- A. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.
- B. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.
- C. Comply with IEEE 241 recommendations for fault currents and time intervals.

D. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.

E. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

F. 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.

G. 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 the level of selective coordination required in the contract documents or by the edition of the National Electrical Code (including any local jurisdiction amendments) the project must comply with. 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.

3.6 OVERCURRENT PROTECTIVE DEVICE SETTING

- A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of overcurrent protective devices within equipment.
- 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.
 - c. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 100.7 and 100.8 in NETA ATS.

3.7 ARC-FLASH HAZARD ANALYSIS

- A. Determine arc-flash incident energy levels and flash protection boundary distances based on the results of the Short-Circuit and Coordination studies. Perform the analysis under worst-case arc-flash conditions for all modes of operation.
- B. Identify all locations and equipment to be included in the arc-flash hazard analysis:
- 1. Include a copy of the facility one-line in the report.
 - 2. Identify the possible system operating modes including tie-breaker positions, and parallel generation.
 - 3. Calculate the arcing fault current flowing through each branch for each fault location.
 - 4. Determine the time required to clear the arcing fault current using the protective device settings and associated trip curves.
 - 5. Select the working distances based on system voltage and equipment class.
 - 6. Calculate the incident energy at each fault location at the prescribed working distance.
 - 7. Determine the hazard/risk category (HRC) for the estimated incident energy.
 - 8. Calculate the flash protection boundary at each fault location.
 - 9. Document the assessment in reports and one-line diagrams.

10. Provide labels to be placed on each piece of equipment analyzed. Label shall show the calculated incident energy and hazard/risk category for the calculated incident energy.
- C. Results of the arc-flash study shall be summarized in a final report containing the following:
1. Basis, method of hazard assessment, description, purpose, scope, and date of the study.
 2. Tabulations of the data used to model the system components and a corresponding one-line diagram.
 3. Descriptions of the scenarios evaluated and identification of the scenario used to evaluate equipment ratings.
 4. Tabulations of equipment incident energies, hazard risk categories, and flash protection boundaries. The tabulation shall identify and clearly note equipment that exceeds allowable incident energy ratings.
 5. Required arc-flash labeling and placement of labels.
 6. Conclusions and recommendations.

END OF SECTION

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes the following lighting control devices:

1. Line-voltage dimming wall switches.
2. Line-voltage wall switch occupancy sensors.
3. Line-voltage dimming wall switch occupancy sensors.
4. Line-voltage occupancy sensors.
5. Line-voltage photoelectric switches.
6. Stand-Alone Low-voltage occupancy sensors.
7. Stand-Alone Low-voltage photoelectric switches.
8. Stand-Alone Low-voltage power packs.
9. Stand-Alone Low-voltage switches.
10. Outdoor motion sensors.
11. Time switches.
12. Lighting contactors.
13. Automatic load control relays.
14. Branch circuit transfer switches.
15. Conductors and Cables for Lighting Control Devices.

1.2 DEFINITIONS

- A. Closed loop: Photosensor control algorithm designed for influence by both daylight and electric light in a space or area.
- B. DPDT: Double pole, double throw.
- C. DPST: Double pole, single throw.

- D. LED: Light-emitting diode.
- E. Open loop: Photosensor control algorithm designed for influence by daylight entering in a space or area.
- F. PIR: Passive infrared.
- G. SPST: Single pole, single throw.

1.3 ADMINISTRATIVE REQUIREMENTS

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

1.4 SUBMITTALS

- A. Product data for the following products:

- 1. Catalog cut sheets, including major and minor motion coverage patterns sensors, time delay and sensitivity adjustability settings, load restrictions, and performance specification items indicating compliance with this specification for all lighting control devices.

- B. Shop Drawings:

- 1. Occupancy sensors and photoelectric switches
 - a. Show installation details.
 - b. Lighting plan showing location, mounting height, orientation and coverage area of each sensor and coordination with other trades.
 - c. Interconnection diagrams showing field-installed wiring.
 - d. Include diagrams for power, signal, and control wiring.
 - e. For any manufacturer submitted other than that listed as the Basis of Design, provide the following information for Engineer review:
 - 1) Factory-generated occupancy sensor and photoelectric switch layouts on project lighting plans with sensor location, orientation and product type clearly marked on plans. Sensor placement shall be coordinated with project reflected ceiling plan layout, ceiling heights, lights, diffusers, and any other ceiling devices and equipment.
 - 2) Samples for review of finish, color and texture.
 - 3) List of any deviations to this specification or Basis of Design products.

- C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. Occupancy sensors and photoelectric switches:

- a. Manufacturer's installation instructions, including instructions for storage, handling, protection, examination, preparation, start-up calibration and installation.
- b. Product data clearly showing sensor field adjustments, including dip switch setting definitions and location of settings within sensors.
- c. Manufacturer's maintenance, including operating and adjustment instructions.

2. Timeclocks

- a. Description of programmed timeclock settings at time of substantial completion.

1.5 QUALITY ASSURANCE

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

B. Occupancy sensors and photoelectric switches

1. Products supplied shall be from a single manufacturer that has been continuously involved in the manufacturing of occupancy sensors for a minimum of 5 years.
2. Products shall be manufactured by an ISO 9001 certified manufacturing facility.
3. Manufacturer shall test all equipment prior to shipment.

1.6 WARRANTY

A. Manufacturers shall provide a five (5) year warranty for sensors and accessories from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES FOR LIGHTING CONTROL DEVICES

- A. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables.
- B. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG.

- C. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG.
- D. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG.
- E. Provide all necessary conductor and cabling required for operation of the controls and control systems specified. This includes power and control wiring required for the controls to operate as described.

PART 3 - EXECUTION

3.1 INSTALLATION

A. GENERAL

- 1. Install devices and associated power packs and wiring in accordance with manufacturer's instructions and applicable codes.

B. OCCUPANCY/VACANCY SENSORS AND PHOTOELECTRIC SWITCHES

- 1. Arrange a pre-installation meeting with manufacturer's factory authorized field representative, at Owner's facility, to verify placement of sensors and installation criteria.
- 2. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage areas specified in manufacturer's literature. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms or areas that are to be provided with sensors. Provide additional sensors as required to properly and completely cover the respective areas.
- 3. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems and partition assemblies.
- 4. Occupancy sensors with ultrasonic or dual-technology sensing technologies shall be located not closer than 4 feet from the nearest edge of air supply devices or similar obstructions that would adversely affect the sensor performance.
- 5. Adjust time delay setting of occupancy sensors to de-energize loads after space has been unoccupied for period of time indicated on the Drawings.
- 6. Install outdoor photoelectric switches with clear view of the northern sky unless noted otherwise on the Drawings.
- 7. Adjust settings of photoelectric switches to turn on lighting at illumination level indicated on the Drawings.
- 8. Install devices and auxiliary equipment in compliance with manufacturer's instructions and recommendations.

9. Install relay units where concealed from view and where accessible.
10. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
11. Install switchbox mounted occupancy sensors at same elevation as other lighting control switches.

C. WIRING

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

3.2 IDENTIFICATION

- A. General: Provide identification complying with requirements specified in Division 26 Section "Identification for Electrical Systems."
- B. Power and control wiring: Identify using marker tapes.
 1. Identify controlled circuits in lighting contactors.
 2. Identify circuits or luminaries controlled by photoelectric switches and occupancy sensors at each sensor.
- C. Components: Label each component with self-laminating computer printed labels, using a unique designation matching control drawing.
- D. Cover plates: Refer to drawings for labeling requirements of certain cover plates for manual switches, or similar devices, requiring labeling for user information.
- E. Buttons/switches:
 1. Engraved from manufacturer. Refer to drawings for detailed requirements and text for labeling.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 2. Operational Test: Test all occupancy sensors in test mode to confirm sensor coverage and sensitivity of sensor per manufacturer's instructions. Upon completion of tests, set sensor time delay as indicated on Lighting Control Device Schedule. Follow testing and adjustment procedures as written in the manufacturer's installation instructions for each sensor model.
- B. Lighting control devices that fail tests and inspections are defective work. Remove, replace, and retest devices that fail tests.

3.4 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
- B. Photoelectric switch Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project for this purpose.

3.5 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Lighting Control Systems."
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training" and Division 26 Section "Lighting Control Systems" for additional information

END OF SECTION

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1500 kVA:
 - 1. Distribution transformers.

1.2 SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, technical certification sheets and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Transformer ratings including:
 - a. kVA
 - b. Primary and secondary voltage
 - c. Taps
 - d. Basic impulse level (BIL) for equipment over 600 volts
 - e. Design impedance
 - f. Insulation class and temperature rise
 - g. Sound level.
- C. Qualification Data: For testing agency.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.3 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."
- E. Transformers shall meet the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment".
- F. All transformers shall be UL listed and bear the UL label.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.5 COORDINATION

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Products.

2. ACME Electric Corporation; Power Distribution Products Division
3. General Electric Company.
4. Siemens Energy & Automation, Inc.
5. Hammond Company
6. Sola/Hevi-Duty
7. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: One leg per phase. Cores shall be constructed of high grade, non-aging silicon steel. The core and coil assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. The completed core and coil shall be bolted to the base of the enclosure but isolated by means of rubber, vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor or strap sized in accordance with UL and NEC requirements. The neutral shall be brought to a stud to facilitate the required external grounding of the secondary
- C. Coils: Continuous windings without splices except for taps.
 1. Internal Coil Connections: Brazed or pressure type.
 2. Coil Material: Copper.
- D. Connections to transformers shall be by flexible metal conduit and using flexible couplings.
- E. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.
- F. Wiring/Terminations:
 1. Recommended external cable shall be rated 90 degrees C (sized at 75 degrees C ampacity) for encapsulated and 75 degrees C for ventilated designs.
 2. Connectors should be selected on the basis of the type and cable size used to wire the specific transformer.
 3. Lug kits shall be provided by the Manufacturer of the transformer.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

- B. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Enclosures: Unless otherwise specified, transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. Enclosures shall have a baked polyester powder coat finish-gray in color and suitable for interior or exterior applications. Enclosures shall be constructed so that there are no exposed live parts. Enclosures shall have a removable front cover to allow access to internal parts and wiring terminations
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
 - 2. Transformer locations:
 - a. Dry locations:
 - 1) Ventilated
 - 2) NEMA 250, Type 2.
 - b. Damp or wet:
 - 1) Ventilated. Provide weather shields over ventilation openings.
 - 2) NEMA 250, Type 3R.
 - c. Corrosive locations:
 - 1) Totally enclosed, non-ventilated
 - 2) NEMA 250, Type 4X, stainless steel
 - 3. The maximum temperature of the enclosure shall not exceed 90 degrees C.
 - 4. The maximum temperature of the top of the enclosure shall not exceed 50°C rise above a 40°C ambient.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finish Color: Gray.
- E. Taps for Transformers 25 kVA through 500 kVA: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- F. Insulation Class for transformers 15 kVA and larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature
- G. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 - 1. Complying with the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment" efficiency levels.

2. Tested in accordance with federal law 10 CFR Part 431.
- H. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 2. Indicate value of K-factor on transformer nameplate.
 3. K-Factor rated transformers shall have an impedance range of 3% to 5%, and shall have a minimum reactance of 2% in order to prevent excessive neutral current when supplying loads with large amounts of third harmonic.
 4. 115 degree C temperature rise.
 5. All cores to be constructed with low hysteresis and eddy current losses. The core flux density shall be well below the saturation point to prevent core overheating and excessive sound level caused by harmonic voltage distortion.
 6. Transformers shall be common core construction. Transformers utilizing more than one core, or Scott-T connections, shall not be acceptable.
 7. Three-phase transformer secondary neutral terminals shall be sized for 200% of the secondary phase current.
 8. The transformer shall be mounted on vibration absorbing pads.
- I. Mounting Methods.
1. Transformers 75 KVA and larger shall be floor mounted unless indicated otherwise. Transformers 45 KVA and smaller may be wall mounted where wall construction is suitable for the load. Floor mounted transformers shall be securely bolted to a 4 inch house keeping pad with vibration isolation pads. Wall mounted or suspended transformers shall have a means of isolating vibration from the support.
 2. Transformers up through 1000 KVA shall be mounted on elastomeric vibration isolation pads. Pad shall be constructed of neoprene, rubber, glass fiber, or a combination thereof. Pads shall be "ribbed" or "waffled" in texture. Pads shall be selected for smallest durometer (hardness), preferably less than 50. Deflection of pad shall be .25" static minimum. Stack pads until the desired deflection is achieved.
 3. Wall Mounting: Manufacturer's standard brackets.
 4. Suspended Mounting: See transformer mounting detail on plans.
- J. Fungus Proofing: Permanent fungicidal treatment for coil and core.
- K. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

- L. Low-Sound-Level Requirements: Maximum sound levels (NEMA ST 20), when factory tested according to IEEE C57.12.91, as follows:

1. 9 kVA and Less: 40 dBA
2. 30 to 50 kVA: 45 dBA
3. 51 to 150 kVA: 50 dBA
4. 151 to 300 kVA: 55 dBA
5. 301 to 500 kVA: 60 dBA
6. 501 to 700 kVA: 62 dBA
7. 701 to 1000 kVA: 64 dBA
8. 1001 to 1500 kVA: 65 dBA

2.4 IDENTIFICATION DEVICES

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

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to ANSI C57.12.01 and IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

2.6 FACTORY TESTING

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
1. Ratio tests at the rated voltage connection and at all tap connections
 2. Polarity and phase relation tests on the rated voltage connection
 3. Applied potential tests
 4. Induced potential test
 5. No-load and excitation current at rated voltage on the rated voltage connection

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Use flexible conduit under the provisions of Division 26 Section "Raceways and Boxes for Electrical Systems" for connections to transformer case. Minimum flexible conduit length shall be two (2) feet.
- D. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

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

3.6 CLEANING

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

PART 4 - DRAWING COORDINATION – DELETE THIS PARAGRAPH WHEN DONE WITH DESIGN

- 4.1 TYPE(S) OF TRANSFORMERS (DRY TYPE, PAD MOUNTED, ETC.) IF MORE THAN ONE TYPE IS USED.
- 4.2 TRANSFORMER RATING AND PHASES: SINGLE OR THREE PHASE.
- 4.3 VOLTAGE RATINGS. FOR HIGH VOLTAGE, INDICATE NOMINAL SYSTEM VOLTAGE, E.G., 13,800 V, RATHER THAN VOLTAGE CLASS (15 KV). FOR LOW VOLTAGE, INDICATE NOMINAL SYSTEM VOLTAGE, E.G., 480/277 V.
- 4.4 WINDING CONNECTIONS, SUCH AS DELTA OR GROUNDED WYE, FOR PRIMARY AND SECONDARY CONNECTIONS OR DIAGRAM OF TRANSFORMER CONNECTIONS.
- 4.5 LOCATIONS OF TRANSFORMERS ON PLANS. INDICATE PHYSICAL SIZE AND RELATION TO ADJACENT ITEMS AND MOUNTING, INCLUDING CLEARANCE REQUIRED FOR "HOT-STICK" OPERATIONS.
- 4.6 WIRE SIZES AND TYPES FOR FIELD CONNECTIONS OF THE PRIMARY SIDE, SECONDARY SIDE, BONDING, AND GROUNDING OF THE TRANSFORMER.
- 4.7 DETAILS OF INSTALLATION OF GROUND BUS AND CONDUCTORS AND ACCESS FOR PROVISIONS FOR GROUND RODS.
- 4.8 CONNECTIONS FOR COOLING-FAN POWER AND REMOTE ALARMS.
- 4.9 DETAILS OF MOUNTINGS, SUPPORTS, AND FASTENINGS INCLUDING SEISMIC RESTRAINTS, IF REQUIRED, AND CONCRETE TRANSFORMER BASES.
- 4.10 REQUIRED ACCESSORY ITEMS, SUCH AS DRAIN VALVES, METERS, GAGES, AND PRESSURE RELIEF DEVICES.
- 4.11 LOCATIONS OF INDOOR UNITS IN ENVIRONMENTALLY CONTROLLED SPACE. INCLUDE TEMPERATURE REGULATION, FREEDOM FROM EXCESSIVE AIRBORNE DUST, AND ISOLATION OF ACOUSTICAL NOISE GENERATED BY EQUIPMENT.
- 4.12 CURBING WHERE REQUIRED TO CONTAIN FLUID LEAKAGE FOR LIQUID-FILLED UNITS.

- 4.13 FUSE RATINGS FOR FUSE-PROTECTED TRANSFORMERS.
- 4.14 MEDIUM-VOLTAGE-CABLE TERMINATION TYPE AND PROVISION FOR HOUSING THE TERMINATION AT THE TRANSFORMER.
- 4.15 PROVISION FOR SECONDARY METERING AND MOUNTING ARRANGEMENT OF CURRENT AND POTENTIAL TRANSFORMERS.
- 4.16 ARRANGEMENTS AND RATINGS OF SURGE ARRESTERS. PROVIDE DETAILS FOR ARRESTERS LOCATED OUTSIDE DRY-TYPE TRANSFORMER ENCLOSURES.
- 4.17 DESIGNATIONS OF TRANSFORMERS WITH LOW-SOUND-LEVEL REQUIREMENTS.
- 4.18 ENCLOSURE TYPE, COOLING-SYSTEM CLASS, AND TEMPERATURE-RISE RATING IF NOT COVERED BY THE SPECIFICATIONS.
- 4.19 BASIC IMPULSE LEVEL RATING, VOLTAGE TAP ARRANGEMENT, AND IMPEDANCE IF NOT COVERED BY THE SPECIFICATIONS.
- 4.20 KEY INTERLOCKING OF TRANSFORMER COMPARTMENT ACCESS DOORS OR TAP-CHANGER HANDLE IN INTERLOCKING SCHEME DIAGRAM.
- 4.21 DETAILS OF BUSWAY CONNECTIONS TO THE TRANSFORMER'S SECONDARY TERMINALS.
- 4.22 SPECIFIC LABELING REQUIREMENTS.

END OF SECTION

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Service and distribution switchboards 600 V and less.
- B. Surge Protection Devices.
- C. Disconnecting and overcurrent protective devices.
- D. Instrumentation.
- E. Control power.
- F. Accessory components and features.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.3 SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.

5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
 6. Detail utility company's metering provisions with indication of approval by utility company.
 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit electronic files, in an SKM-compatible format.
 9. Include schematic and wiring diagrams for power, signal, and control wiring.
 10. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchboard where pipe and ducts are prohibited. Show switchboard layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- C. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section "Overcurrent Protective Device Coordination Study"
- D. Qualification Data: For qualified Installer.
- E. Field Quality-Control Reports:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- F. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Routine maintenance requirements for switchboards and all installed components.
 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. 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.
- F. Comply with NEMA PB 2.
- G. Comply with NFPA 70.
- H. Comply with UL 891.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Handle and prepare switchboards for installation according to NECA 400.
- C. Environmental Limitations:
 - 1. Do not deliver or install switchboards until spaces are enclosed and weather tight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- D. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- E. Remove loose packing and flammable materials from inside switchboards.
- F. Connect temporary electric heating (250 W per section) to prevent condensation.

1.6 FIELD CONDITIONS

- A. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding 104 deg F (40 deg C).

2. Altitude: Not exceeding 6600 feet (2000 m).
- B. Service Conditions: NEMA PB 2, usual service conditions, as follows:
 1. Ambient temperatures within limits specified.
 2. Altitude not exceeding 6600 feet (2000 m).

1.7 WARRANTY

- A. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SERVICE AND DISTRIBUTION SWITCHBOARDS, 600 VOLTS AND LESS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable products by one of the following, the first listed manufacturer was used as the basis of design:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Front-Connected, Front-Accessible Switchboards:
 1. Main Devices: Fixed, individually mounted.
 2. Branch Devices: Panel mounted.
 3. Sections front and rear aligned.
- C. Nominal System Voltage: As indicated.
- D. Main-Bus Continuous: As indicated.
- E. Indoor Enclosures: Steel, NEMA 250, Type 1.
- F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- G. Barriers: Between adjacent switchboard sections.
- H. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

- I. Cubical Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
 - 1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
 - 2. Space-Heater Power Source: Transformer, factory installed in switchboard.
- J. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.
- K. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- L. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.
- M. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- N. Pull Box on Top of Switchboard:
 - 1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 - 2. Set back from front to clear circuit-breaker removal mechanism.
 - 3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
 - 4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
 - 5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
- O. Buses: Three phase, four wire unless otherwise indicated.
 - 1. Phase, and Neutral Buses:
 - a. Material:
 - 1) Hard-drawn copper, 98 percent conductivity.
 - b. Size: Ampacity as indicated on drawings, with uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 1) Neutral bus: 200 percent of the ampacity of phase buses unless otherwise indicated, equipped with connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus
 - 2. Ground Bus: Equipped with connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

- a. Material: Hard-drawn copper, 98 percent conductivity
 - b. Size: Minimum-size required by UL 891
3. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- P. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- Q. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.
- R. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.
- S. Service Equipment Label: Where used as service entrance equipment, provide NRTL label for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.
- T. Main switchboards used as service entrance equipment shall be provided with infrared windows in quantities and locations to provide line-of-sight viewing of all cable terminations on the line side of the main overcurrent protective device.

2.2 SURGE PROTECTION DEVICES

- A. Provide surge protective devices as required by Division 26 Section "Surge Protective Devices".
- B. Panelboards requiring SPD and the location of the devices shall be as indicated on the Drawings.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Arc Flash Mitigation
 - 1. Overcurrent devices, 1200 A and larger, shall be provided with an energy-reducing active arc flash mitigation capability. The energy-reducing active arc flash mitigation system shall allow the operator to enable a maintenance mode using a switch which enables a preset accelerated instantaneous override trip to reduce arc flash energy. An LED on the trip unit shall indicate the trip unit is in the maintenance mode.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

- a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
 6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style as indicated, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 - f. Under voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - g. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.4 INSTRUMENTATION

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:

1. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Megawatts: Plus or minus 2 percent.
 - e. Megavars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
 2. Mounting: Display and control unit flush or semi flush mounted in instrument compartment door.

2.5 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
- B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NECA 400.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install switchboards and accessories according to NECA 400.
- C. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- F. Install filler plates in unused spaces of panel-mounted sections.
- G. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- H. Install spare-fuse cabinet.
- I. Comply with NECA 1.

3.3 IDENTIFICATION

- A. General: Provide identification complying with requirements specified in Division 26 Section "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard with a nameplate.
- C. Device Nameplates: Label each branch circuit device in distribution switchboard with a nameplate.
- D. Warning Labels:
 - 1. Label each switchboard with a warning label in accordance with NFPA70 and NFPA 70E.
- E. Identify field-installed conductors, interconnecting wiring, and components.
- F. Instruction Sign: Provide clear, detailed, written instructions, permanently attached to the electrical gear being served by it for staff reference.
- G. One-Line: Provide a laminated, color-coded, large-format one-line diagram showing the new work is to be provided and installed in the associated electrical room.

3.4 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.5 FIELD QUALITY CONTROL

- 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NECA 400. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove necessary panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Switchboard will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Distribution panelboards.
- B. Lighting and appliance branch-circuit panelboards.
- C. Disconnecting and Overcurrent Protective Devices.
- D. D
- E. Lighting and Appliance Branch-Circuit Panelboards.
- F. Surge Protection Devices.
- G. Accessory Components and Features.

1.2 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. SPD: Surge Protection Device

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 3. Detail bus configuration, current, and voltage ratings.
 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 5. Include evidence of NRTL listing for series rating of installed devices.
 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 7. Include wiring diagrams for power, signal, and control wiring.
 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit electronic files, in an SKM-compatible format.
- C. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section "Overcurrent Protective Device Coordination Study"
- D. Qualification Data: For qualified testing agency.
- E. Field Quality-Control Reports:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- F. Panelboard Schedules: Submit final panelboard directories.
- G. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Routine maintenance requirements for panelboards and all installed components.
 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. 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.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 FIELD CONDITIONS

- A. Environmental Limitations:
 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 1. Ambient temperatures within limits specified.
 2. Altitude not exceeding 6600 feet (2000 m).
- C. Interruption of Existing Electric Service: Do not interrupt electric service to occupied facilities. Refer to Division 26 Section "General Electrical Requirements" for allowable outages.

1.8 WARRANTY

- A. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable products by one of the following, the first listed manufacturer was used as the basis of design:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Enclosures: Flush- or surface-mounted cabinets as noted.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Kitchen and/or Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.
 - 2. Hinged Front Cover: Entire front trim hinged to box.
 - 3. Door: Standard door with concealed hinges, within hinged trim cover. Secured with vault-type latch with tumbler lock; keyed alike.
 - 4. Skirt for Surface-Mounted Panelboards: Same gauge and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 5. Gutter Extension and Barrier: Same gauge and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 6. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - 7. Directory Card: Inside panelboard door, mounted in transparent card holder.

- C. Incoming Mains Location: Top and/or bottom as required.
- D. Buses: Three phase, four wire unless otherwise indicated.
 - 1. Phase, and Neutral Buses:
 - a. Material:
 - 1) Hard-drawn copper, 98 percent conductivity.
 - b. Size: Ampacity as indicated on drawings, with uniform capacity for entire length of panelboard's sections.
 - 1) Neutral bus: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus
 - 2. Ground Bus: Equipped with connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 - a. Material: Hard-drawn copper, 98 percent conductivity
 - b. Size: Minimum-size required by UL 67
- E. Line-Side Conductor Connectors (Lugs):
 - 1. General: Suitable for use with conductor material and sizes. Connections shall comply with requirements of Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".
 - 2. Material: Same as bus material.
 - 3. Capacity rating: Same as associated bus.
 - 4. Type: Provide mechanical type unless otherwise indicated on Drawings, refer to schedules and one-line diagram.
- F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating – Fully Rated: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

- A. See manufacturers above.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.

- C. Doors: For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.
- D. Mains: As indicated on drawings.
- E. Branch Overcurrent Protective Devices:
 - 1. Connection to bus:
 - a. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
 - b. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
 - 2. Type: Provide types as indicated on drawings and as defined below.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. See manufacturers above.
- B. Panelboards: Circuit breaker type: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: As indicated on drawings.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. See manufacturers above.
- B. Arc Flash Mitigation
 - 1. Overcurrent devices, 1200 A and larger, shall be provided with an energy-reducing active arc flash mitigation capability. The energy-reducing active arc flash mitigation system shall allow the operator to enable a maintenance mode using a switch which enables a preset accelerated instantaneous override trip to reduce arc flash energy. An LED on the trip unit shall indicate the trip unit is in the maintenance mode.
- C. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical type unless otherwise indicated on Drawings, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 1) Mounting: Integral
 - e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - g. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
 - h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - i. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.5 SURGE PROTECTION DEVICES

- A. Provide surge protective devices as required by Division 26 Section "Surge Protective Devices".
- B. Panelboards requiring SPD and the location of the devices shall be as indicated on the Drawings.

2.6 ACCESSORY COMPONENTS AND FEATURES

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Wall-Mounted Panelboards: Install panelboards on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For panelboards not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Mount top of trim 72 inches (1788 mm) above finished floor unless otherwise indicated.
- E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- F. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- G. Install filler plates in unused spaces.

- H. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- J. Comply with NECA 1.

3.3 IDENTIFICATION

- A. General: Provide identification complying with requirements specified in Division 26 Section "Identification for Electrical Systems."
- B. Panelboard Nameplates: Label each panelboard with a nameplate.
- C. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate.
- D. Warning Labels: Label each panelboard with a warning label in accordance with NFPA 70 and NFPA 70E.
 - 1. Exception: Do not install NFPA 70 working clearance requirements on flush panelboards and similar equipment in finished spaces.
- E. Identify field-installed conductors, interconnecting wiring, and components; complying with Division 26 Section "Identification for Electrical Systems."
- F. Panel Directories
 - 1. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
 - 2. Note the date the directory was created/updated.
 - 3. Create directory after loads have been balanced.

3.4 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.5 FIELD QUALITY CONTROL

- A. 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.
- B. Acceptance Testing Preparation:
 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- C. Tests and Inspections:
 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 PROTECTION

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

END OF SECTION

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Receptacles: Single, duplex, USB/duplex, ground-fault circuit interrupters (GFCI), and tamper resistant (TR).
2. AC Wall Switches: Single- and double-pole, three- and four-way, maintained and momentary, pilot light and lighted toggle.
3. Device Wall Plates.
4. Emergency Power Off Buttons

1.2 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. IG: Isolated Ground
- C. PIR: Passive Infrared.
- D. RFI: Radio Frequency Interference
- E. SPD: Surge Protective Device
- F. USB: Universal Serial Bus
- G. TR: Tamper Resistant

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product data for the following products:
1. Provide manufacturer's catalog information specifically marked to indicate which devices are being furnished, and showing dimensions, colors, and configurations for all devices, including, but not limited to: Receptacles, AC wall switches, cover plates, power poles, and multi-outlet assemblies.
- C. Shop drawings for:

1. List of legends and description of materials and process used for pre-marking wall plates.

D. Samples:

1. One for each type of device and wall plate specified, in each color specified.
2. Samples will be returned after review, and, if accepted by the Architect and Engineer, may be installed on the Project.

E. Field quality-control test reports.

F. Operations and Maintenance Data:

G. Warranty: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated cover plate from a single manufacturer and through one source. Where practical and possible, obtain all wiring devices and associated cover plates from a single manufacturer and one source.

- B. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 10 years.

C. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that are acceptable to authorities having jurisdiction.
2. Marked for intended use.

D. Comply with NFPA 70.

1.5 COORDINATION

- A. Receptacles for Equipment Furnished by Owner or Under Other Divisions or Contracts: Match plug configurations.

1.6 EXTRA MATERIALS

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

1. Wall Plates: One for every 10 of each type (i.e., style, size, and finish) installed, but no fewer than two of each type.

1.7 SPARES

- A. Furnish spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Wall Plates: One for every 10 of each type (i.e., style, size, and finish) installed, but no fewer than two of each type.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

- A. Wiring devices are defined as single discrete units of electrical distribution systems, such as convenience receptacles, switches, special purpose receptacles, and similar, which are intended to carry, but not use electrical energy. Install wiring devices as required by the Specifications and where indicated on the Drawings.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Receptacles and Switches:
 - a. Cooper Wiring Devices.
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Mfg. Company Inc.
 - d. Pass & Seymour/Legrand; Wiring Devices Div.
 - 2. Emergency Power Off Buttons:
 - a. GE Industrial.
 - b. Square D/Groupe Schneider NA.
 - c. Eaton.
- B. In other Part 2 articles below, where lists of manufacturers and device catalog numbers are included, the following additional requirements apply to product selection:
 - 1. Additional Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include manufacturers listed in individual articles below, in addition to those listed in Paragraph "Manufacturers" above.

2.3 FINISHES

A. Color:

1. Wiring devices connected to normal power systems: As selected by Architect, unless otherwise indicated or required by NFPA 70. Cover plates: As selected by the Architect.

- B. Manufacturer's model numbers listed are to establish the quality of the wiring devices. Coordinate the proper suffixes in order to provide the correct color as specified above.

2.4 CONVENIENCE RECEPTACLES:

- A. The catalog numbers listed below are generally for 20A rated devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide receptacles equivalent to those specified for 20A, but rated for 15A.

- B. Duplex convenience receptacles: Heavy Duty Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.

<u>Manufacturer</u>	<u>Duplex</u>	<u>Single</u>
Cooper	5362	5351
Hubbell	5352A	HBL5361
Leviton	5352	5261
Pass & Seymour	5362	5361

- C. Duplex tamper resistant convenience receptacles: Heavy Duty Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.

<u>Manufacturer</u>	<u>Duplex</u>
Cooper	TR5362
Hubbell	HBL8300SGA
Leviton	8300-SGG
Pass & Seymour	TR5362

- D. Duplex weather resistant convenience receptacles: Heavy Duty Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.

<u>Manufacturer</u>	<u>Duplex</u>
Cooper	TWR270
Hubbell	5362WR
Leviton	WBR20

Pass & Seymour WR5862

- E. USB/duplex convenience receptacles: NEMA 5-20R, 125V, 20A, tamper resistant, 3-wire, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding; with integral USB charger having two ports, USB 2.0 compatible, 5VDC, 3A output (min).

<u>Manufacturer</u>	<u>Single</u>
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Cooper	TR7756
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Hubbell	USB20X2
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Leviton	T5832
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Pass & Seymour	TR5362USB
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2.5 GFCI RECEPTACLES

- A. Ground fault circuit interrupter type receptacles: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.

<u>Manufacturer</u>	<u>Specification Grade</u>
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Cooper	VGF2
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Hubbell	GF20LA
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Leviton	T7899-H
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Pass & Seymour	2095
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- B. Ground fault circuit interrupter type weather-resistant receptacles: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.

<u>Manufacturer</u>	<u>Specification Grade</u>
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Cooper	WRVGF20
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Hubbell	GFTR20
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Leviton	W7899
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Pass & Seymour	2095TRWR
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- C. Ground fault circuit interrupter type tamper and weather-resistant receptacles: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.

<u>Manufacturer</u>	<u>Specification Grade</u>
Cooper	TWRVGF20
Hubbell	GFTR20
Leviton	W7899-T
Pass & Seymour	2095TRWR

- D. Ground fault circuit interrupter with Blank Face: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.

<u>Manufacturer</u>	<u>Specification Grade</u>
Cooper	VGFD20
Hubbell	GFBF20
Leviton	7595
Pass & Seymour	2085

2.6 SPECIAL/MISCELLANEOUS DEVICES

- A. Special purpose receptacles: Grounding type, UL listed with NEMA configurations as indicated below or on the Drawings.

<u>Manufacturer</u>	<u>Dryer 14-30R</u>	<u>Range 14-50R</u>	<u>Switch/Receptacle</u>	<u>Clock 5-15R</u>
Cooper	1257	1258	--	TR775
Hubbell	HBL9430A	HBL9360	--	HBL5235
Leviton	278	279	5225	5261-CH
Pass & Seymour	3864	3849	671	S3733

2.7 SWITCHES

- A. The catalog numbers listed below are generally for 20A rated devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide switches equivalent to those specified for 20A, but rated for 15A.
- B. Switches: Heavy Duty Specification grade, rated for 120/277V, 20A, back and side wired, and UL listed and labeled.

<u>Manufacturer</u>	<u>1 Pole</u>	<u>2 Pole</u>	<u>3 Way</u>	<u>4 Way</u>
Cooper	AH1221	AH2221	AH3221	AH4221
Hubbell	1221	1222	1223	1224
Leviton	1221-2	1222-2	1223-2	1224-2
Pass & Seymour	CSB20AC1	CSB20AC2	CSB20AC3	CSB20AC4

- C. Pilot Light switches: 20A, single pole switch with red neon lighted handle. Toggle shall be illuminated when the switch is in the "ON" position.

<u>Manufacturer</u>	<u>1 Pole</u>	<u>2 Pole</u>	<u>3 Way</u>
Cooper	AH2221PL	AH222PL	AH2223PL
Hubbell	HBL1221PL	HPL1222PL	HBL1223PL
Leviton (120V)	1221-PLX	1222-PLX	1223-PLX
Leviton (277V)	1221-7PLX (277V)	1222-7PLX	1223-7PLX
Pass & Seymour	PS20AC1-XSL	PS20AC2-XSL	PS20AC3-XSL

- D. Key operated light switches: Same as standard light switches except toggle handle shall be operated by a factory provided key.

<u>Manufacturer</u>	<u>1 Pole</u>	<u>2 Pole</u>	<u>3 Way</u>	<u>4 Way</u>
Cooper	221L	2222L	2223L	2224L
Hubbell	HBL1221L	HBL1222L	HBL1223L	HBL1224L
Leviton	1221-2KL	122202KL	1223-2KL	1224-2KL
Pass & Seymour	PS20AC1-L	PS20AC2-L	PS20AC3-L	PS20AC4-L

- E. Switches for use with mechanically-held, electrically-operated lighting contactors: Single pole, double throw, momentary, center off switch, rated for 120/277V, and UL listed and labeled.

<u>Manufacturer</u>	<u>1 Pole</u>
Cooper	1995
Hubbell	HBL1557
Leviton	1257-I
Pass & Seymour	1251

2.8 COVER PLATES

- A. Wet Location Weatherproof Receptacle Cover Plates (Outlet Box Hood): NEMA 3R weather resistant recessed or flush mount, die cast aluminum lockable cover. Configure cover for horizontal mounting of receptacle or as indicated otherwise. Back box must be suitable for conduit connections. Coordinate back box with wall depth.

<u>Manufacturer</u>	<u>Horizontal</u>
Thomas & Betts	CKMU
Eaton	WIUMV-1
Hubbell	WP26MH
Leviton	IUM1H-GY

- A. Damp and Wet Location Weatherproof switch cover plates: Fabricated of cast aluminum or cast zinc, sealed water-tight and UL listed for wet locations.

<u>Manufacturer</u>	<u>1 Gang</u>	<u>2 Gang</u>
Appleton	FSK	--
Raco	5100 Series	--
Steel City	SW Series	--

- B. Other locations: Single and combination types to match corresponding wiring devices and manufacturer of wiring devices specified herein.

1. Plate securing screws: Metal with head color to match finish plate.
2. Material for Finished Spaces: High impact nylon, minimum 0.10-inch thick. Refer to "Finishes" above for color..
3. Material for Unfinished Spaces and surface mounted wiring devices: Galvanized steel.
4. Masonry walls and oversized wall openings: Jumbo size plates with same material as indicated above.

2.9 EMERGENCY POWER OFF BUTTONS

- A. Push/Pull Button Operators: 30MM, watertight/oiltight, heavy duty, 600V maximum ac/dc, 10A continuous, 2 position maintained, non-illuminated, push/pull button operator. Provide with 1 normally open and 1 normally closed contact block.

<u>Manufacturer</u>	<u>Red Button</u>
Schneider	9001SKR9RH13
GE Industrial	CR104PBM91R5C
Eaton	10250T5B621

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install all wiring devices plumb, level, and square with building lines. Wiring device bodies shall extend to the finished surface of the walls, ceiling or floor, as applicable, without projecting beyond them.
- C. Connect wiring devices by wrapping conductors around screw terminals. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- D. Connect wiring device grounding terminal to branch circuit equipment grounding conductor and bond to metal outlet box. Exception: Do not bond grounding terminals of isolated ground receptacles to the outlet box.
- E. Install devices shown on wood trim, cases or other fixtures symmetrically and, where necessary, set with the long dimensions of the plate horizontal, or ganged in tandem.

- F. Unless dimensioned otherwise, install wiring devices a minimum of 24 inches from the closest edge of any sink.
- G. Install switches with OFF position down.
- H. Install cover plates on all switches, receptacles, and blank outlets.
- I. Locate wiring devices so that the cover plate does not have to be cut to be installed.
- J. Where devices are shown near wall openings, coordinate location if corner guards are to be installed so that cover plates do not require cutting.
- K. Install cover plates after the wall has been finished (painted, wall paper, etc).
- L. Install device boxes in brick or block walls such that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
- M. Provide safety-type, tamper-resistant receptacles in all areas where receptacles are mounted less than 5'-6" AFF and are easily accessible to children.
- N. Provide safety-type, tamper-resistant receptacles in psychiatric patient rooms. Provide tamperproof screws on faceplates of all wiring devices in psychiatric patient rooms.
- O. Provide engraved nameplate on emergency off buttons.
- P. Provide ground fault circuit interruption capability for all 120V receptacles 50A or less and all 208/240V receptacles 100A or less in code required locations. Locations include, but are not limited to: bathrooms, kitchens/food prep areas, exterior locations and within 6' of sinks. Interruption capability can be achieved via a GFCI circuit breaker or a GFCI receptacle.
- Q. Provide type and quantity of normally open and/or normally closed contacts for emergency off buttons to meet the sequence of operations shown.
- R. Install wiring devices shown back-to-back on a common wall offset a minimum of 12" horizontally to reduce sound transmission between rooms.

3.2 GENERAL

- A. Outlets are only approximately located on the small scale Drawings. Use great care in the actual location by consulting the various large scale detailed Drawings used by other Division trades, and by securing definite locations from the Architect.
- B. Do not use multi-conductor circuits, with a shared neutral, for any GFCI receptacle circuit. Provide a separate neutral conductor with all GFCI receptacle circuits.
- C. Provide twist-locking type receptacles or other special type receptacles where indicated and as scheduled on the Drawings.

3.3 EXAMINATION

- A. Verify that outlet boxes are installed at proper height and are flush with the finished surface.
- B. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- C. Verify that floor boxes are adjusted properly and are flush with the finished surface.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.4 PREPARATION

- A. If required, provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from in and around outlet boxes.

3.5 MOUNTING HEIGHTS

- A. Coordinate locations of outlet boxes provided under Division 26 Section “Common Work Results for Electrical”.
- B. Unless noted otherwise, install wiring devices at mounting heights indicated in the Electrical Symbols Legend on the construction drawings.

1. Receptacles:

a. General:

- 1) Unless indicated otherwise, install vertically with the ground slot mounted at the top.
- 2) Where Installed horizontally, install neutral slot mounted at the top.

b. Above counters:

- 1) Mount vertically.

c. Mechanical and electrical equipment rooms and janitors closets:

- 1) Mount horizontally.

d. Garages:

- 1) Wet location: Mount horizontally.
- 2) Other locations: Mount vertically.

e. Weatherproof exterior receptacles:

- 1) Mount horizontally.

- f. GFCI receptacles: Same as general receptacles.
 - g. Concrete Block Walls: Dimensions above may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom or top of boxes, as applicable, are at block joints.
- 2. Switches:
 - a. Above counters: Same as for receptacles.
 - b. Concrete Block Walls: Dimension may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom of boxes are at block joints.
 - c. Walls with wainscoting: 6 inches minimum above wainscoting, but not exceeding 48 inches above finished floor.
- 3. Telephone/Data Outlet Boxes:
 - a. General: Match mounting height of adjacent wiring device listed above.
- 4. Emergency Power Off Buttons:
 - a. General: Match requirements of switches listed above.
 - b. Wall-mounted telephone: 40 inches above finished floor.

3.6 IDENTIFICATION

- A. Label all devices fed down stream of GFCI protected receptacles as "GFCI PROTECTED".
- B. Comply with Division 26 Section "Identification for Electrical Systems."
 - 1. Receptacles and Switches: Identify panelboard and circuit number from which served, using:
 - a. Adhesive Film Label with Clear Protective Overlay, but with letter/number height of 1/4 inch, on face of plate, for exterior and damp/wet locations.

3.7 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
- D. Test all wiring devices for electrical continuity and proper polarity of connections.
- E. Test each GFCI receptacle device for proper operation.

- F. Correct wiring devices incorrectly installed.
- G. Repair or replace all damaged items or damaged finishes at no expense to the Owner.

3.8 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.9 CLEANING

- A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in:
 - a. Control circuits
 - b. Enclosed switches
 - c. Panelboards
 - d. Switchboards
 - e. Enclosed controllers
 - f. Motor-control centers.
2. \Spare-fuse cabinets.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 3. Current-limitation curves for fuses with current-limiting characteristics.
 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit on translucent log-log graph paper if available.

5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

- B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. All items requested under "Product Data".

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. 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.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

1.4 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.5 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.6 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fuses: Equal to 10percent of quantity installed for each size and type, but no fewer than two of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Edison Fuse, Inc.
 - 3. Mersen Electrical Power
 - 4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
 - 2. Finish: Gray, baked enamel.
 - 3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
 - 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- C. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.
- D. Install spare-fuse cabinet(s).

3.2 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Service Entrance:

- a. Greater than 600A:
 - 1) Class L, time delay
- b. 600A or less:
 - 1) Class RK1, time delay

2. Feeders:

- a. Greater than 600A:
 - 1) Class L, time delay
- b. 600A or less:
 - 1) Class RK1, time delay

3. Motor Branch Circuits:

- a. Class RK1 time delay

4. Other Branch Circuits:

- a. Class RK1, time delay

5. Control Circuits:

- a. Class CC fast acting

LEE'S SUMMIT MIDDLE SCHOOL #4
PACKAGE 3 – BUILDING & SITE
LEE'S SUMMIT, MISSOURI

13-20102-00
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END OF SECTION

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Shunt trip switches.
4. Enclosures.

1.2 DEFINITIONS

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

1.3 PERFORMANCE REQUIREMENTS

1.4 SUBMITTALS

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

- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Qualification Data: For qualified testing agency.
- D. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Manufacturer's field service report.
- F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

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

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2010 m).
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Construction Manager's written permission.
 - 4. Comply with NFPA 70E.

1.7 COORDINATION

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

1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 SHUNT TRIP SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Ferraz Shawmut, Inc.
 - 3. Littelfuse, Inc.
- B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
- C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
- E. Accessories:
 - 1. Oiltight key switch for key-to-test function.
 - 2. Oiltight green ON pilot light.
 - 3. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
 - 4. Form C alarm contacts that change state when switch is tripped.
 - 5. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

3.3 IDENTIFICATION

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

3.4 FIELD QUALITY CONTROL

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.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

END OF SECTION

SECTION 264313 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section includes Surge Protection for:
 - 1. Service Entrance Suppressors (Externally Mounted SPD'S At Service Entrance Gear)
 - 2. Panelboard Suppressors (Externally Mounted SPD'S At Panelboard Location)
- B. Refer to Definitions below for clarification of type selection.

1.2 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. VPR: Voltage Protection Rating. The average of measured limiting voltage before and after Nominal Discharge Testing (In), rounded up to one of UL's VPR categories (Table 63.1 of ANSI/UL 1449 Third Edition) such as 330 volt, 400 volt, 500 volt, etc. VPR is posted on each device UL label.
- C. In or In or Inominal: Nominal Discharge Current. Peak value of surge current, selected by the manufacturer, through the SPD having current wave shape of 8/20 microseconds where the SPD remains functional after 15 surges. In is posted on the device UL label.
- D. SPD: Surge Protective Device. Previously Transient Voltage Surge Suppressor (TVSS), a broad class of protective devices, installed parallel with the distribution panel or service disconnect, meant to protect downstream electrical distribution equipment from the effects of high voltage surges on the line.
- E. MCOV: Maximum Continuous Operating Voltage. The maximum continuous operating voltage rating of a Metal Oxide Varistor (MOV) that can be applied without the MOV being damaged and/or destroyed by thermal runaway. MCOV is posted on the device UL label.
- F. SCCR: Short Circuit Current Rating. The maximum current rating the SPD can sustain without being damaged and/or destroyed. SCCR is posted on the device UL label.
- G. SPD Type:
 - 1. TYPE 1: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service equipment overcurrent device, as well as the load side, including watt-hour meter socket enclosures and intended to be installed without an external overcurrent protective device. Type 1 devices are required for Master Certification of Lightning Protection System installations under UL 96A.
 - 2. TYPE 2: Permanently connected SPDs intended for installation on the load side of the service equipment overcurrent device, including SPDs located at the branch circuit panel.

3. TYPE 3: Point-of-utilization SPDs, installed at a minimum conductor length of 10 meters (30 feet) from the electrical service panel to the point of utilization, e.g., cord-connected, direct plug-in, receptacle type and SPDs installed at the utilization equipment being protected. The distance (10 meters or 30 feet) is exclusive of conductors provided with or used to attach SPD's.
4. TYPE 4: Component SPDs, including discrete components as well as component assemblies for installation on panelboards or control panels.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate SPD devices with Division 26 Section "Electrical Power Monitoring and Control."

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include model number, SPD type, system voltage, phases, modes of protection, voltage Protection rating (VPR), and Nominal Discharge Current (I_n), and accessories required.
- B. Qualification Data: For qualified testing agency.
- C. Product Certificates: For SPD devices, from manufacturer.
- D. Field quality-control reports.
- E. Operation and Maintenance Data: For SPD devices to include in emergency, operation, and maintenance manuals.
- F. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member Company of NETA or an NRTL.
 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled by UL or other Nationally Recognized Testing Laboratory (NRTL) as defined in NFPA 70, by a testing agency, and marked for intended location and application.
- C. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.
- D. Comply with NEMA LS 1.
- E. Comply with ANSI/ UL 1449 Third Edition.
- F. Comply with NFPA 70.

- G. The SPD shall be compliant with the restrictions of the Hazardous Substances (RoHS) Directive 2002/95/EC.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Refer to Division 26, Section “General Electrical Requirements”.
- B. Service Conditions: Rate SPD devices for continuous operation under the following conditions unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 - 2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
 - 3. Humidity: 0 to 85 percent, noncondensing.
 - 4. Altitude: Less than 20,000 feet (6090 m) above sea level.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 SERVICE ENTRANCE SUPPRESSORS (EXTERNALLY MOUNTED SPD'S AT SERVICE ENTRANCE GEAR)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB USA.
 - 2. AC Data Solutions.
 - 3. Advanced Protection Technologies Inc. (APT).

4. Atlantic Scientific.
 5. Current Technology Inc.; Danaher Power Solutions.
 6. Danaher Power Solutions; United Power Products.
 7. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 8. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 9. Intermatic, Inc.
 10. LEA International.
 11. Leviton Mfg. Company Inc.
 12. Liebert Corporation; a division of Emerson Network Power.
 13. Northern Technologies, Inc.; a division of Emerson Network Power.
 14. Siemens Energy & Automation, Inc.
 15. Square D; a brand of Schneider Electric.
 16. Surge Suppression Incorporated.
- B. Surge Protection Devices:
1. Comply with UL 1449 Third Edition.
 2. Modular design (with field-replaceable modules) Non-modular design.
 3. Fuses, rated at 200-kA interrupting capacity.
 4. Fabrication using bolted compression lugs for internal wiring.
 5. Integral disconnect switch.
 6. Redundant suppression circuits.
 7. Redundant replaceable modules.
 8. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 9. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
 10. LED indicator lights for power and protection status.
 11. Audible alarm, with silencing switch, to indicate when protection has failed.

12. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 13. Four-digit transient-event counter set to totalize transient surges.
- C. Peak Single-Impulse Surge Current Rating, per phase:
1. 250kA per mode/500kA
- D. Nominal Discharge current (I_n): The SPD shall be tested to meet UL 1449 Third Edition Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.
1. Type 1 SPD's shall be tested and labeled at 20kA per mode.
 2. Type 2 SPD's shall be tested and labeled at 10kA per mode.
- E. Protective Impulse: The SPD shall be tested by application of 15 repetitive impulses of 3000 amps and 6000 volts having an 8x20 microsecond wave shape
- F. Protection modes and UL 1449-Third Edition VPR for grounded wye circuits 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V	600Y/347 V
Line to Neutral	1200	700	1500
Line to Ground	1200	700	1500
Neutral to Ground	1200	700	1500

2.2 PANELBOARD SUPPRESSORS (EXTERNALLY MOUNTED SPD'S AT PANELBOARD LOCATION)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB USA.
 2. AC Data Solutions.
 3. Advanced Protection Technologies Inc. (APT).
 4. Atlantic Scientific.
 5. Current Technology Inc.; Danaher Power Solutions.
 6. Danaher Power Solutions; United Power Products.
 7. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

8. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 9. Intermatic, Inc.
 10. LEA International.
 11. Leviton Mfg. Company Inc.
 12. Liebert Corporation; a division of Emerson Network Power.
 13. Northern Technologies, Inc.; a division of Emerson Network Power.
 14. Siemens Energy & Automation, Inc.
 15. Square D; a brand of Schneider Electric.
 16. Surge Suppression Incorporated.
- B. Surge Protection Devices:
1. Comply with UL 1449 Third Edition.
 2. Modular design (with field-replaceable modules) Non-modular design.
 3. Short-circuit current rating complying with UL 1449 Third Edition, and matching or exceeding the panelboard short-circuit rating and redundant suppression circuits; with individually fused metal-oxide varistors.
 4. Fuses, rated at 200-kA interrupting capacity.
 5. Fabrication using bolted compression lugs for internal wiring.
 6. Integral disconnect switch.
 7. Redundant suppression circuits.
 8. Redundant replaceable modules.
 9. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 10. LED indicator lights for power and protection status.
 11. Audible alarm, with silencing switch, to indicate when protection has failed.
 12. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 13. Four Six-digit transient-event counter set to totalize transient surges.

- C. Peak Single-Impulse Surge Current Rating per phase:
1. 250kA per mode/500kA
- D. Nominal Discharge current (I_n): The SPD shall be tested to meet UL 1449 Third Edition Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.
1. Type 1 SPD's shall be tested and labeled at 20kA per mode.
 2. Type 2 SPD's shall be tested and labeled at 20kA per mode.
- E. Protection modes and UL 1449 Third Edition VPR for grounded wye circuits, 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V
Line to Neutral	1200	700
Line to Ground	1200	700
Neutral to Ground	1200	700

2.3 ENCLOSURES

- A. All SPD Units shall be fully enclosed unless otherwise noted. Provide enclosures suitable for the locations indicated and as described below:
1. Indoor Enclosures:
 - a. NEMA 250 Type 1 constructed of a polymer or steel material

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install SPD devices at service entrance on load side, with ground lead bonded to service entrance ground.
- B. Install SPD devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
1. Provide multiple, 60 -A circuit breaker as a dedicated disconnecting means for SPD unless otherwise indicated.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
 2. After installing SPD devices but before electrical circuitry has been energized, test for compliance with requirements.
 3. Complete startup checks according to manufacturer's written instructions.
- B. SPD device will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

- A. Do not energize or connect any equipment to their sources until SPD devices are installed and connected.
- B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to maintain SPD devices.

END OF SECTION

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Included in the work of this section are labor, material, and appurtenances required to complete the work of this Section as specified herein, including, but not limited to:
 - 1. Interior light fixtures, lamps, LEDs, reflectors, lenses or faceplates, ballasts, transformers, drivers and power supplies (includes exterior light fixtures normally installed on exterior surfaces of buildings).
 - 2. Exit signs.
 - 3. Light fixture supports.
 - 4. Emergency Lighting Mini-Inverter.
 - 5. Coordination.
 - 6. Quality assurances.
 - 7. Specific requirements.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING:

- A. Division 26 Section "General Electrical Requirements" for general requirements and related documents that apply to this Section.
- B. Division 26 Section "Common Work Results for Electrical" for raceways, conductors, cables, and cords.
- C. Division 26 Section "Exterior Lighting" for exterior light fixtures, except those normally mounted on exterior surfaces of buildings.
- D. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
- E. Division 26 Section "Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.3 SUBMITTALS

- A. General:
 - 1. Only those light fixtures and manufacturers per each fixture type designated and listed in the Light Fixture Schedule or on the Drawings, and approved in accordance with paragraph 1.4-

SUBSTITUTIONS of this Section, or both, will be accepted. Where the Light Fixture Schedule indicates an allowance to be made for a specific light fixture, the price is a contractor price and monies shall be allotted for freight, installation, and lamping (if designated). Alternate manufacturers presented at bid shall be disqualified.

2. Submit all light fixtures, specified for use on this Project, in a single submittal package of portfolios, so that all light fixtures can be reviewed at one time.
 3. Prepare portfolios from manufacturer's standard specification sheets, and include the fixture tag indicated on the Light Fixture Schedule to identify each light fixture. Do not combine more than one light fixture type on a single sheet.
 4. Fixture or other materials shall not be shipped, stored, or installed into the work without approval of shop drawings.
 5. Modifications to fixtures shall be in accordance with Architect's comments.
- B. Product Data: For each type of light fixture, collated and bound in sets, and arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
1. Summary page with the following for each light fixture type
 - a. The number, type and wattage of the light fixture LEDs (including, but not limited to, assemblies, arrays, bars or modules).
 - b. Light fixture driver or auxiliary device manufacturer, number and type.
 2. Fixture cut sheets with name of manufacturer and options to be provided marked, including, but not limited to, voltage, lensing, and finish/color.
 - a. Descriptive information providing physical characteristics of light fixture, including, but not limited to, materials, dimensions, fixture efficacy and/or efficiency, and verification of indicated parameters.
 - b. For LED fixtures, include also L70 lifetime and wattage of luminaire including driver/power supply losses.
 - 1) Include MacAdam ellipse step information for:
 - a) All interior light fixtures
 - b) Exterior luminaires installed on exterior building surfaces specified with 80 CRI or greater.
 3. Light fixture mounting details, including non-standard outlet boxes.
 4. Construction of light fixture housing and door (if applicable).
 5. Power supply, transformer, and/or driver cut sheet with options marked, providing physical description of auxiliary device including, but not limited to, voltage, power factor, amperage, wattage, and maximum remote distance charts between device and light fixture.

6. Light fixture finish and color (if applicable).
 7. Lamp cut sheet with options marked, providing physical description of lamps, including, but not limited to, voltage, wattage, efficacy, CCT, CRI, lumens, and life expectancy.
 - a. For LED lamps, include also number of MacAdam ellipse steps and L70 lifetime.
 8. Emergency ballast cut sheet: Descriptive cut sheets providing physical description of emergency ballasts for use in normal light fixtures, including, but not limited to, complete battery information, lumens, and method for testing per NFPA 101.
- C. Shop Drawings: Show details of non-standard or custom light fixtures. Indicate dimensions, finish color, including, but not limited to, custom color, weights, methods of field assembly, components, features, accessories, and modifications. Scaled documents shall be provided for custom fixtures.
- D. Submittal Schedule
1. Within 30 days of Division 26 contractor award, shop drawings covering all light fixtures within this section shall be forwarded to architect to begin approval process. Any shop drawings submitted after the required time frame will require the contractor to submit only the 1st named manufacturer and associated specification data listed on the fixture schedule as the only approved manufacturer. No substitutions will be allowed after the specified time frame.
 2. Within 15 days of “approved” and “approved as noted” shop drawings, contractor shall forward to Architect a guaranteed ship date for each specified fixture.
 3. Within 15 days after contractor’s receipt of “reject and resubmit” or “not approved” shop drawings, contractor shall provide Architect with resubmitted shop drawings for only those fixtures deemed unacceptable.
 4. Contractor is responsible to call to the attention of the Architect any submittals that have not been returned to him in a timely manner that may affect delivery of fixtures or as otherwise affecting Section 1.4.D of this specification.
- E. Control Wiring
- F. Coordination Drawings: Refer to architectural reflected ceiling plans or details for exact location of light fixtures; engineering documents shall not be referenced for exact fixture positions. Contractor shall check and verify dimensions and details on drawings before proceeding with the work. If any question arises about the true meaning of drawings, refer the matter to the Architect, whose decision is final. In no case proceed with work with any uncertainty. Architectural documents shall show and coordinate with assistance from installers of items involved:
1. Light fixtures.
 2. Suspended ceiling components.
 3. Structural members to which suspension systems for light fixtures will be attached.
 4. Other items in finished ceiling including the following:
 5. Air outlets and inlets.

6. Speakers.
 7. Sprinklers.
 8. Smoke and fire detectors.
 9. Occupancy sensors.
 10. Access panels.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For lighting equipment and fixtures to include in operation and maintenance manuals.
- I. Warranties: Special warranties specified in this Section.

1.4 SUBSTITUTIONS

- A. Refer to Division 26 Section “General Electrical Requirements”.
- B. Prior to the Bid Date, substitutions will not be considered unless the Architect/Engineer have received written request for approval at least ten calendar days prior to the date for receipt of Bids. Include in each such request the Light Fixture Schedule designation, name of the material or equipment for which it is to be substituted and complete Product Data for the proposed substitute, as defined in SUBMITTALS above, and all other information necessary for an evaluation. Provide interior point-by-point calculations, under both normal and emergency lighting conditions, as applicable, if required by the Engineer. Submit a \$100.00 review fee to the Engineer with each such point-by-point calculation for use of electronic base files. The fee will be returned if the substitution is added to the specification.
- C. During the Bid
1. Any proprietary, sole-sourced light fixture listed in the fixture schedule shall be unit priced only. Unit prices shall be clearly identified on the bid form.
 2. Representative agents shall be allowed to offer mini-lot pricing (MLP). MLP shall be defined as:
 3. Agents can group only specified fixtures they represent, and
 4. Only represent in the region where the specification originated, and
 5. Exclude all fixtures outside their represented lines from the MLP, and
 6. Sole-sourced (proprietary) light fixtures shall not be included in the MLP.
- D. After the Bid Date, proposals to substitute light fixtures for those shown on the Drawings or specified herein, will only be considered as a deduct. Submit proposed substitutions separately, in Submittal form, with a list of proposed substitutions together with a deduct price for each substitution. Proposed substitutions will then be reviewed by the Architect/Engineer.

- E. During the construction period, no substitutions shall be considered if product delay is due to contractor's failure to order products in a timely manner after presentation of fixture schedules and specifications. Additional costs associated with air freight or special factory runs to meet schedule due to contractor's error shall be at the expense of contractor.
- F. The Architect/Engineer has the final authority as to whether the light fixture is an acceptable replacement to the specified item. The proposed substitution may also be rejected for aesthetic reasons if felt necessary or desirable. In the event the proposed substitutions herein described are rejected, provide the specified item(s).

1.5 DEFINITIONS

- A. CCT: Correlated color temperature
- B. CFL: Compact Fluorescent
- C. CRI: Color-rendering index.
- D. CU: Coefficient of utilization.
- E. EISA: Energy Independence and Security Act of 2007.
- F. HID: High-intensity discharge.
- G. L70: minimum 70% maintained initial-rated lumens at average rated life for LEDs
- H. LED: Light Emitting Diode
- I. LED Lamp: Replaceable LED light source with an integral driver within envelope of lamp. Lamp/Base types may include MR16/bi-pin, PAR/medium base, etc.
- J. LED Module: Light source that contains LEDs, and may include additional components such as lenses, reflectors, or refractors, however do not include drivers.
- K. LER: Light fixture (Luminaire) efficiency rating.
- L. Light Fixture: Complete light fixture, including ballast housing if provided.
- M. RCR: Room cavity ratio.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 2. Marked for intended use.
- B. Comply with NFPA 70.

- C. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- D. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- E. Regulatory Agencies: Provide fixtures conforming to nationally- or internationally-recognized accredited testing agencies, such as U.S., ETL, ARL, or others in acceptance with local code enforcement policy.
- F. Electrical Components and Devices: Provide only fixtures that comply with National Electric Code (NEC), and in particular to Section 410. All ceiling recessed fixtures, whether indicated in a catalog number or not, shall be equipped with an integral thermal protection device.
- G. FMG Compliance: Light fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

1.7 COORDINATION

- A. Unless otherwise noted, perform all electrical Work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other Divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.
- B. Coordinate layout and installation of light fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including, but not limited to, HVAC equipment, fire-suppression system, and partition assemblies. Contractor shall arrange his installation in proper relation to other work so that there shall be no interference, damage or delay to other trades' work
- C. Give ample notice of any special openings or rough-in work required for placing electrical/lighting work so as to avoid cutting or removal of completed work.
- D. Where work of this Section is to be flush or concealed, install it so it does not project beyond finished lines of walls, ceilings or floor surface.
- E. Verify all ceiling systems and coordinate light fixture type and accessories prior to ordering light fixtures. Coordinate and cooperate with ceiling installer in regards to the location and installation of light fixtures.

1.8 WARRANTY

- A. General Guarantee: For a period of one year after Owner's initial acceptance and establishment of the beginning date of the guarantee period, and at no cost to the Owner, Contractor shall promptly furnish and install replacements for any fixtures or components deemed by the Owner as defective in workmanship under normal operating conditions, excluding lamp replacement as noted in Section 1.10.A.1. Contractor shall repair installed equipment on the job site to Owner's satisfaction. For any time during said guarantee period that fixtures are not fully functional due to defects in material or workmanship, Contractor shall provide or pay for suitable temporary light fixtures, and shall remove

said temporary fixtures upon installation of replacement elements. Contractor shall furthermore guarantee replacement fixtures for a period of one year following replacement.

- B. Contractor shall not be held responsible for damage of fixtures or equipment components occurring after the beginning of the guarantee period due to acts of vandalism, acts of war, or acts of God.
- C. LED Warranties: Shall be free from defects in materials and workmanship for the period indicated from date of factory shipment.
 - 1. LED Luminaires, including LED modules, arrays and drivers: Five years.
 - 2. LED Lamps: Three years.
- D. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Lighting Batteries: 3 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining coverage years.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Additional light fixtures and accessories as scheduled on the Drawings.
- B. Where light fixtures are specified with tamper proof hardware, provide the Owner with three tools for each different type of hardware.

1.10 SPARES

- A. Furnish spare materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Battery and Charger Data: One for each emergency lighting unit.
 - 3. Ballasts and/or Drivers: 2 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

- A. In Light Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 LIGHT FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Provide light fixtures as shown on the drawings and/or specified. This shall include all material and labor to securely hang light fixtures, clean them and make them completely ready for use. Provide all hangers, supports, and miscellaneous hardware required to install light fixtures. Provide additional tie wires connected to structure where required.
- B. Light fixture models scheduled on the Drawings are to show the manufacturer, grade and style of light fixtures required. Regardless of the manufacturer's catalog number suffixes indicated, provide all options and features as described in the Light Fixture Schedule.
- C. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures. Manufacturer of recessed fixtures shall provide mounting brackets suitable for connection to ceiling system structure. Modifications to standard mounting brackets shall be coordinated with contractor and delivered with fixture so that no delays to product delivery shall be allowed.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling when secured in operating position.
- G. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.
 4. Laminated Silver Metallized Film: 90 percent.
- H. Plastic Diffusers, Covers, and Globes:
1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

- a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
 - b. UV stabilized.
- 2. Glass: Annealed crystal glass, unless otherwise indicated.
- I. Where located within structural concrete, light fixture housing and any other luminaire components in direct contact with concrete shall be effectively coated and/or covered to prevent chemical reactions with the concrete in accordance with the American Concrete Institute Code.
- J. Fixture Finishes:
 - 1. Apply fixture finishes after fabrication in a manner that assures a durable wear-resistant surfacing. Give exposed metal surfaces (brass, bronze, aluminum and others) and finished castings, except chromium-plated or stainless steel parts, an even coat of high-grade meth/acrylate lacquer or transparent epoxy.
- K. Reflectors:
 - 1. Provide aluminum reflectors or reflecting cones for downlight style fixtures comprised of #12 aluminum reflector sheet, 0.57 inch (15 gauge) or heavier and free of tool-making indentations, including spinning lines caused by assembly techniques. All reflectors shall be of first-quality, anodized finish :Alzak” with specular or semi-specular finish and color as selected. Provide specular reflectors with no apparent brightness above 45 degrees from Nadir and semi-specular, diffuse reflectors with no apparent brightness above 75 degrees from Nadir.
- L. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps, LEDs, ballasts and/or drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp, LEDs and/or driver characteristics:
 - a. "USE ONLY" and include specific LED type.
 - b. LED type, wattage, beam angle (if applicable) for LED luminaires. Indicate maximum allowed wattage.
 - c. CCT and CRI for all luminaires.

2.3 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
 - 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

- a. Battery: Sealed, maintenance-free, nickel-cadmium type.
- b. Charger: Fully automatic, solid-state type with sealed transfer relay.
- c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
- d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
- e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
- f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
- g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.4 DRIVERS FOR LED LUMINAIRES

- A. Description: Designed for type and quantity of LED diodes of light fixture. Drivers shall tolerate sustained open circuit and short circuit output conditions without damage. Driver shall be designed for full light output unless dimmer or bi-level control is indicated:
 - 1. Sound Rating: A.
 - 2. Total Harmonic Distortion Rating: Less than 20 percent. Shall comply with ANSI C82.77.
 - 3. Transient Voltage Protection: IEEE C62.41, Category A or better.
 - 4. Power Factor: 0.90 or higher at full load.
 - 5. Interference: Comply with 47 CFR, Chapter 1, Part 15, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
 - 6. Driver shall operate with maximum sustained variations of +/-10 input voltage and frequency with no damage to driver.
 - 7. Driver output shall be regulated to maximum +/- 5% published load range or requirements of downstream LED fixture.
 - 8. LED Current Crest Factor: 1.5 or less.
 - 9. LED drivers shall not over-drive LEDs at a current or voltage above LED rated values in order to increase LED lumen output.

10. Meets EN610000 for input harmonics.

11. ROHS Compliant.

B. Dimming Drivers:

1. Dimming Range: Visually flicker-free, strobe-free, continuous dimming of source as follows, unless specifically noted otherwise in the Light Fixture Schedule whichever is more stringent:
 - a. Luminaires: 100 to 10 percent of rated lumens.
 - b. Lamps: 100 to 20 percent of rated lumens.
2. 0-10V dimming drivers: Compliant with IEC 60929 standard for 4-wire dimming.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and LED indicated.
4. Control: Coordinate to ensure that the dimming driver, power supply, controller, dimming module, and/or wallbox dimmer and connecting wiring are compatible.

2.5 EMERGENCY LIGHTING MINI-INVERTER

A. Manufacturer

1. Basis-of-Design Product: Insert manufacturer name from below is the Basis-of-Design manufacturer. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified below:
 - a. Iota Engineering #IIS Series
 - b. Cooper Lighting Surelites #CMFT Series
 - c. Highlites #PFT Series
 - d. Assurance Emergency Lighting #SI Series

B. Description – Self-contained uninterruptible or fast-transfer inverter designed for normal and emergency operation of connected lighting loads. Unit shall be capable of operating LED fixtures with no break or interruption of illumination. UL 924 listed and meets NFPA 101, NEC and local codes.

1. Battery: Sealed, maintenance-free lead-calcium or lead-acid type. 68 deg F to 86 deg F optimum operating temperature.
2. Charger and Electronics: Fully automatic, thermal compensating variable rate battery charger. AC lockout feature, low battery voltage disconnect; DC overload, short circuit and brownout protection. 32 deg F to 104 deg F electronics operating temperature.
3. Operation: Inverter shall allow connected emergency lighting fixtures to be normally on. Upon loss of normal utility power, the emergency lighting fixtures will be delivered emergency power

for their full lumen output rating with no break (<2 ms) in illumination for a minimum of 90 minutes.

4. 120V, single phase input and output voltages. Input voltage shall match output voltage, and +/- 3% voltage regulation, 60 Hz.
 5. Maximum remote mounting distance of 1000'-0".
 6. Housing: Designed for surface mounting installation to floor or wall. 16 gauge steel housing with scratch-resistant powder coat paint finish..
 7. Testing: Integral testing means by either manual test switch or self-testing, self-diagnostic with manual testing capabilities.
 8. Onboard LED indicating lights for inverter status indication.
 9. Manufacturer's warranty or minimum 2 year warranty on electronics and battery and seven-year prorata warranty on battery, whichever is greater.
 10. Overload and short circuit protection on input and output of inverter. Circuit breakers or fusing on output side.
- C. Where wattage of inverter is different from Basis-of-Design manufacturer's selected wattage, provide quantity of inverters as required to meet design intent. If additional inverters are required, confirm additional equipment will fit within available space constraints.
- D. Where physical size of inverter is different from Basis-of-Design manufacturer, confirm equipment will fit within available space constraints.

2.6 LAMPS GENERAL

- A. Unless specific manufacturers and lamp types are called for in the Light Fixture Schedule, all lamps provided for this project shall be by the same manufacturer. Lamps shall be manufactured by:
1. Eiko
 2. General Electric
 3. Osram/Sylvania
 4. Philips
 5. Soraa
 6. Venture
- B. All lamps shall be new and shall be delivered to the project in manufacturer's original sealed package.
- C. Substitutions of specific lamp manufacturer as addressed in Fixture Schedule shall not be allowed. Costs associated with re-lamping due to non-compliance with specification, for both labor and material costs, shall be the sole responsibility of the contractor. For those fixtures with lamp included in fixture,

contractor shall coordinate with manufacturer to ensure only approved lamp(s) is (are) installed. Lamp manufacturers indicated on Fixture Schedule are for reference. Where required, contractor shall coordinate with Owner regarding national purchasing agreement of specific lamp manufacturers. Purchasing of lamps, whether through competitive bidding of listed manufacturers or proprietary supply, shall be at the discretion of the Owner.

2.7 LED LAMPS AND LUMINAIRES

- A. Comply with ANSI C78.377 for white light LED color range. Unless noted otherwise in the Light Fixture Schedule, LED color quality characteristics shall be 80 CRI minimum and 4000K CCT.
- B. LED binning specification tolerance to be within 3 MacAdam ellipses of rated values or as indicated in the Light Fixture Schedule, whichever is more stringent. All LEDs used for same fixture type throughout the project to originate from same production bin.
- C. Unless indicated otherwise in the Light Fixture Schedule, minimum 70% maintained initial-rated lumens at average rated life of as follows:
 - 1. LED luminaires: 50,000 hours
- D. ROHS compliant
- E. Manufacturer of LED chips will be evaluated based on the manufacturer's product literature and data. At a minimum, LED fixtures or lamps will incorporate Bridgelux, Cree, Nichia, Osram or Xicato LEDs; additional manufacturers may be considered however the Architect or Engineer has the authority to reject other manufacturers for technical or aesthetic reasons if felt necessary or desirable.

2.8 AUXILIARY DEVICES FOR LOW VOLTAGE AND LED FIXTURES

- A. Provide remote power supplies, drivers and/or transformers for light fixtures as required for a complete and operational system. Where equipment is not indicated as plenum rated, provide an additional enclosure for the device(s) suitable for the installed environment.

2.9 LIGHT FIXTURE SUPPORT COMPONENTS

- A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- B. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge.
- E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

- F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.10 TRANSFORMERS FOR LOW VOLTAGE FIXTURES

- A. Provide transformers to low voltage lamps which are suitable for the electrical characteristics of the supply circuits to which they are to be connected. For remote electronic or magnetic transformers, contractor shall remote transformers so as to reduce voltage drop. For 25 amp low-voltage linear systems, contractor shall not daisy-chain 25A loaded runs together. Contractor shall provide home-run from end of run to remote transformer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify conditions of equipment and installation prior to beginning work.
- B. Verify that equipment is ready for connecting, wiring, and energizing.

3.2 INSTALLATION

- A. Light Fixtures: All work shall be executed to present a neat appearance. Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Light Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
 - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from light fixture corners.
 - 2. Support Clips: Fasten to light fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
 - 4. Install at least one independent support rod or wire from structure to a tab on light fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- C. Suspended Light Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end. Provide suitable connectors or collars to connect adjoining units to appear as a continuous unit.

4. Decorative pendant mounted light fixtures
 - a. Provide cord and/or stem lengths to match elevations above finished floor as indicated on architectural elevations. If architectural elevations do not indicate suspension heights, coordinate with Architect to determine final suspension heights. Regardless, contractor shall not field cut pendants or order rigid stems without elevation approval from Architect. Pendant suspensions on electrical documents are for reference only.
 - 1) Cord-mounted: Manufacturers shall supply luminaires with flexible, field cutting cords. Contractor shall field cut cords as required.
 - 2) Field-cutable, rigid-stem mounted: Manufacturers shall supply luminaires with field cutting rigid stems. Contractor shall field cut stems as required.
 - 3) Factory-cut rigid stem mounted: Contractor shall provide rigid stem dimensions to the manufacturer as required.
 - b. Junction boxes used to feed light fixtures shall be covered by manufacturer supplied canopy plates.
- D. Installation within non-standard ceilings, including, but not limited to, wood and metal ceilings.
 1. For recessed downlight light fixtures, specification is based on standard throats to accommodate ceiling thicknesses of $\frac{3}{4}$ " or less. If non-standard ceiling (such as wood, thickened gypboard ceilings and metal plank type) require throats greater than $\frac{3}{4}$ ", modifications to manufacturer's standard $\frac{3}{4}$ " throat shall be determined by Architect and Contractor prior to shop drawing submission.
 2. For light fixtures recessed into metal ceilings, rigidly support light fixture to ensure that trim fits flush with ceiling plane.
- E. Connect wiring according to Section "260519 - Low-Voltage Electrical Power Conductors and Cables."
- F. Through wiring of recessed light fixtures, in suspended ceilings, is not permitted. Connect each light fixture by a whip to a junction box. The whip shall be of sufficient length to allow the light fixture to be relocated within a 6-foot radius.
- G. Wall Mounted Light fixtures
 1. Unless otherwise noted, conceal all raceways and back boxes for wall mounted light fixtures. Coordinate all wall-mounted light fixtures with interior elevations. Where specific elevations or dimensions are not indicated, verify the correct location with Architect prior to installation. Contractor shall supply structure to support weight of fixture.
- H. Auxiliary Devices for low voltage and LED Fixtures
 1. Install device within maximum remote distances and with wiring sized per manufacturer's recommendations.
 2. In public areas or other areas where remote device visibility is undesirable, install device where concealed from view, well ventilated and accessible. Provide access panels as required.

3. Provide label on device indicating fixture type and location/room served along with panelboard circuit number.
4. Properly support remote lighting devices, including transformers, power supplies, and drivers, per Code and manufacturer's recommendations.

3.3 DIMMING

- A. For dimmable light fixtures, provide both control and power wiring between light fixture and control device and between light fixtures. Quantity of low voltage and line voltage wiring and wire type shall be per manufacturer's recommendations. At a minimum, provide the following based on control type at either 120V or 277V, unless recommended otherwise by the manufacturer:
 1. 0-10V – two low voltage conductors and two line voltage conductors plus ground
 2. 2-Wire dimming – two line voltage conductors plus ground
 3. 3-Wire dimming – three line voltage conductors (1 for control and two for power) plus ground
 4. DALI – two low voltage conductors and two line voltage conductors plus ground
 5. Proprietary digitally addressable – as required per the manufacturer
 6. DMX – two line voltage conductors plus ground and DMX cabling
- B. Coordinate light fixture and control device dimming types for compatibility.

3.4 COORDINATION

- A. Light fixtures shown on the Electrical Drawings represent general arrangements only. Refer to Architectural Drawings for exact locations.
- B. Coordinate the installation and location of light fixtures with other work and all other trades before installation to avoid conflicts. Coordinate light fixture locations in mechanical rooms with final installed piping and ductwork layouts.
- C. Verify all ceiling systems and coordinate light fixture type and accessories prior to ordering light fixtures. Coordinate and cooperate with ceiling installer in regards to the location and installation of light fixtures.
- D. Wall-Mounted Light fixtures
 1. Coordinate all wall-mounted light fixtures with the architectural features of the building. Where specific elevations or dimensions are not indicated, verify the correct location with the Architect prior to beginning any work.

3.5 ADJUSTING

- A. At the time of substantial completion, aim all track lights, flood lights, spot lights, and other fixtures requiring aiming per the Architect's direction. Contractor shall make provisions for supplying all scaffolds, lifts, and other tools and equipment as required.
- B. Where required, focusing shall be done during hours of darkness. Upon notification by contractor that all fixtures are correct as per shop drawings and functioning, that specified lamps have been verified, lighting designer or Architect shall coordinate with contractor as to a mutually agreed upon time to complete focusing. Failure of contractor to notify Architect during substantial completion will result in failure to comply with specifications.

3.6 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Clean light fixtures of dirt and debris upon completion of the installation. Protect installed light fixtures from damage during the remainder of the construction period.
- C. Upon completion of the installation of light fixtures, and after building circuits have been energized, energize lighting branch circuits to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- D. At the time of final acceptance of this project by the Owner, ensure that all lamps are in working order and all light fixtures are fully lamped.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
 - 1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION

SECTION 265600 - EXTERIOR AREA LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following lighting equipment:
 - 1. Exterior LED light fixtures with LED modules and drivers.
 - 2. Poles and accessories.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING:

- A. Division 26 Section "General Electrical Requirements" for general requirements and related documents that apply to this Section.
- B. Division 26 Section "Common Work Results for Electrical" for raceways, conductors, cables, and cords.
- C. Division 26 Section "Grounding and Bonding for Electrical Systems"
- D. Division 26 Section "Raceway and Boxes for Electrical Systems.
- E. Division 26 Section "Underground Ducts and Raceways for Electrical Systems"
- F. Division 26 Section "Identification for Electrical Systems"
- G. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
- H. Division 26 Section "Exterior Athletic Field Lighting" for sports field lighting.
- I. Division 26 Section "Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
- J. Division 26 Section "Enclosed Switches and Circuit Breakers"
- K. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 SUBMITTALS

- A. General:
 - 1. Only those light fixtures and manufacturers per each fixture type designated and listed in the Light Fixture Schedule or on the Drawings, and approved in accordance with paragraph 1.4-SUBSTITUTIONS of this Section, or both, will be accepted. Where the Light Fixture Schedule

indicates an allowance to be made for a specific light fixture, the price is a contractor price and monies shall be allotted for freight, installation, and lamping (if designated). Alternate manufacturers presented at bid shall be disqualified.

2. Submit all light fixtures, specified for use on this Project, in a single submittal package of portfolios, so that all light fixtures can be reviewed at one time.
- B. Prepare portfolios from manufacturer's standard specification sheets, and include the number indicated on the Light Fixture Schedule to identify each light fixture. Do not combine more than one light fixture type on a single sheet.
1. Fixture or other materials shall not be shipped, stored, or installed into the work without approval of shop drawings.
 2. Modifications to fixtures shall be in accordance with Architect's comments.
- C. Product Data: For each light fixture, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
1. Summary page with the following for each light fixture type
 - a. The number, type and wattage of the light fixture lamps or LEDs (including, but not limited to, assemblies, arrays, bars or modules).
 - b. Light fixture ballast, driver or auxiliary device manufacturer, number and type.
 2. Fixture cut sheets with name of manufacturer and options to be provided marked, including, but not limited to, voltage, lensing, and finish/color.
 - a. Descriptive information providing physical characteristics of light fixture, including, but not limited to, materials, dimensions, effective projected area, fixture efficacy and/or efficiency, and verification of indicated parameters.
 - b. For LED fixtures, include also L70 lifetime and wattage of luminaire including driver/power supply losses.
 - 1) Include MacAdam ellipse step information for luminaires specified with 80 CRI or greater.
 3. Light fixture mounting details, including, but not limited to, non-standard outlet boxes.
 4. Construction of light fixture housing and door (if applicable).
 5. .
 - a. For dimming ballasts, also include dimming type technology and dimming range/limits.
 6. Power supply, transformer, and/or driver cut sheet with options marked, providing physical description of auxiliary device including, but not limited to, voltage, power factor, amperage, wattage, and maximum remote distance charts between device and light fixture.
 - a. For dimming LED, also include dimming type technology and dimming range/limits.

7. Lamp cut sheet with options marked, providing physical description of lamps, including, but not limited to, voltage, wattage, efficacy, CCT, CRI, lumens, and life expectancy.
 - a. For LED lamps, include also number of MacAdam ellipse steps and L70 lifetime.
 8. Details of attaching light fixtures and accessories.
 9. Details of installation and construction.
 10. Photometric data, in IESNA format, including LM-79 for LED luminaires, based on laboratory tests of each light fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the light fixture as applied in this Project.
 - a. For indicated light fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining light fixtures shall be certified by manufacturer.
 - b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 11. For pole-mounted LED area lighting fixtures, IES-TM-21 LED luminaire lifetime and lumen maintenance projections.
 12. .
 13. Materials, dimensions, and finishes of poles.
 14. Means of attaching light fixtures to supports, and indication that attachment is suitable for components involved.
 15. Anchor bolts for poles.
 16. Manufactured pole foundations.
- D. Delegated-Design Submittals for Pole-Mounted Exterior Athletic Lighting: Submit the following documents, signed and sealed by a qualified professional engineer:
1. Manufacturer's determination of LLF used in design calculations.
 2. Structural analysis data and calculations used for pole selection and foundations.
 - a. Manufacturer Wind-Load Strength Certification: Submit certification that selected total support system, including poles, complies with AASHTO LTS-4 or as required by the local authority having jurisdiction, whichever is more stringent, for location of project.
 3. Design calculations for the following:
 - a. Target illuminance.
 - b. Point Calculations of horizontal and vertical illuminance, CV, and UG at minimum grid size and area.

- c. Point calculations of horizontal and vertical illuminance in indicated areas of concern for spill light.
 - d. Calculations of source intensity of luminaires observed at eye level from indicated properties nearby the playing fields.
 - e. Short-circuit current calculations for rating of panelboards
 - f. Total connected and estimated peak-demand electrical load, in kilowatts, of lighting system.
 - g. Capacity of feeder and service required to supply the lighting system.
 - h. Design calculations indicating strength of screw foundations and soil conditions on which they are based.
 - i. Design calculations for determination of poured-in-place concrete foundation size and reinforcement
 - 4. Wiring requirements, including, but not limited to, required conductors and cables and wiring methods.
- E. Delegated-Design Submittals for Pole-Mounted Area Lighting: Submit the following documents, signed and sealed by a qualified professional engineer:
- 1. Structural analysis data and calculations used for pole selection and foundations.
 - a. Manufacturer Wind-Load Strength Certification: Submit certification that selected total support system, including poles and equipment anchorage devices, complies with AASHTO LTS-4 or as required by the local authority having jurisdiction, whichever is more stringent, for location of project.
 - 2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
 - 3. Design calculations for the following:
 - a. Design calculations indicating strength of screw foundations and soil conditions on which they are based.
 - b. Design calculations for determination of poured-in-place concrete foundation size and reinforcement
 - 4. Shop Drawings: Submittal Schedule
 - a. Within 30 days from Division 26 Contractor award, shop drawings covering all light fixtures within this section shall be forwarded to architect to begin approval process. Any shop drawings submitted after the required time frame will require the contractor to submit only the 1st named manufacturer and associated specification data listed on the fixture schedule as the only approved manufacturer. No substitutions will be allowed after the specified time frame.

- b. Within 15 days of “approved” and “approved as noted” shop drawings, Contractor shall forward to Architect a guaranteed ship date for each specified fixture.
 - c. Within 15 days after Contractor’s receipt of “reject and resubmit” or “not approved” shop drawings, Contractor shall provide Architect with resubmitted shop drawings for only those fixtures deemed unacceptable.
 - d. Contractor is responsible to call to the attention of the Architect any submittals that have not been returned to him in a timely manner that may affect delivery of fixtures or as otherwise affecting Section 1.4.D of this specification.
5. Show details of non-standard or custom light fixtures. Indicate dimensions, finish color, including, but not limited to, custom color, weights, methods of field assembly, components, features, accessories, and modifications. Scaled documents shall be provided for custom fixtures.
6. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
7. Wiring Diagrams: Power and control wiring.
- F. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 or as noted elsewhere in this specification and that loads imposed by light fixtures and attachments have been included in design. This certification shall be based on design calculations by a professional engineer.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For light fixtures and poles to include in operation and maintenance manuals.
- I. Warranty: Special warranties specified in this Section.

1.4 SUBSTITUTIONS

- A. Refer to Division 26 Section “General Electrical Requirements”.
- B. Prior to the Bid Date, substitutions will not be considered unless the Architect/Engineer have received written request for approval at least ten calendar days prior to the date for receipt of Bids. Include in each such request the Light Fixture Schedule designation, name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including cut sheets, photometric data, and all other information necessary for an evaluation. Provide interior point-by-point calculations if required by the Engineer. Submit a \$100.00 review fee to the Engineer with each such point-by-point calculation for use of electronic base files. The fee will be returned if the substitution is added to the specification.
- C. During the Bid
- 1. Any proprietary, sole-sourced light fixture listed in the fixture schedule shall be unit priced only. Unit prices shall be clearly identified on the bid form.
 - 2. Representative agents shall be allowed to offer mini-lot pricing (MLP). MLP shall be defined as:

- a. Agents can group only specified fixtures they represent, and
 - b. Only represent in the region where the specification originated, and
 - c. Exclude all fixtures outside their represented lines from the MLP, and
 - d. Sole-sourced (proprietary) light fixtures shall not be included in the MLP.
- D. After the Bid Date, proposals to substitute light fixtures for those shown on the Drawings or specified herein, will only be considered as a deduct. Submit proposed substitutions separately, in Submittal form, with a list of proposed substitutions together with a deduct price for each substitution. Proposed substitutions will then be reviewed by the Architect/Engineer.
- E. The Architect/Engineer have the final authority as to whether the light fixture is an acceptable replacement to the specified item. The proposed substitution may also be rejected for aesthetic reasons if felt necessary or desirable. In the event the proposed substitutions herein described are rejected, provide the specified item(s).

1.5 DEFINITIONS

- A. CCT: Correlated color temperature
- B. CRI: Color-rendering index.
- C. CU: Coefficient of utilization.
- D. CV: Coefficient of Variance. The ratio of standard deviation for all illuminance values to the mean illuminance value.
- E. Delegated-Design Submittals: Documents, including, but not limited to, drawings, calculations, and material and product specifications prepared as a responsibility of Contractor to obtain acceptance by Owner and authorities having jurisdiction.
- F. EISA: Energy Independence and Security Act of 2007.
- G. Horizontal Illuminance: Measurement in foot-candles (lux), on a horizontal surface 36 inches above the ground, unless otherwise indicated.
- H. L70: minimum 70% maintained initial-rated lumens at average rated life for LEDs
- I. LED: Light Emitting Diode
- J. LED Lamp: Replaceable LED light source with an integral driver within envelope of lamp. Lamp/Base types may include MR16/bi-pin, PAR/medium base, etc.
- K. LED Module: Light source that contains LEDs, and may include additional components such as lenses, reflectors, or refractors, however do not include drivers.
- L. LER: Light fixture efficacy rating.
- M. Light fixture: Complete light fixture, including ballast housing if provided.

- N. LLD: Lamp Lumen Depreciation.
- O. LLF: Light Loss Factor.
- P. Luminaire: Complete lighting fixture, including ballast housing if provided.
- Q. Pole: Light fixture support structure, including tower used for large area illumination.
- R. Standard: Same definition as "Pole" above.
- S. Target Illumination: Average maintained illumination level, calculated by multiplying initial illuminance by LLF.
- T. UG: Uniformity Gradient; the rate of change of illuminance over a lighted area, expressed as a ratio between the illuminances of adjacent measuring points on a uniform grid.
- U. Vertical Illuminance: Measurement in foot-candels (lux), in four directions on a vertical surface, at an elevation coinciding with plane height of horizontal measurements.

1.6 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of light fixture and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in latest AASHTO LTS-4.
- B. Live Load: Single load of 500 lbf, distributed as stated in latest AASHTO LTS-4.
- C. Ice Load: As stated in latest AASHTO LTS-4 or as required by the local authority having jurisdiction, whichever is more stringent.
- D. Wind Load: As stated in latest AASHTO LTS-4 or as required by the local authority having jurisdiction, whichever is more stringent.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
 - 1. Manufacturer's responsibilities include fabricating sports lighting and providing professional engineering services needed to assume engineering responsibility.
 - 2. Engineering Responsibility: Preparation of delegated-design submittals and comprehensive engineering analysis by a qualified professional engineer.
- C. Light Fixture Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with IEEE C2, "National Electrical Safety Code."
- F. Comply with NFPA 70.

1.8 COORDINATION

- A. Unless otherwise noted, perform all electrical Work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other Divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.
- B. Coordinate layout and installation of light fixtures, poles, foundations, and underground raceway system with other above- and below-grade site construction and utilities. Notify Architect/Engineer of conflicts before proceeding with the Work.

1.9 WARRANTY

- A. General Guarantee: For a period of one year after Owner's initial acceptance and establishment of the beginning date of the guarantee period, and at no cost to the Owner, Contractor shall promptly furnish and install replacements for any fixtures or components deemed by the Owner as defective in workmanship under normal operating conditions, excluding lamp replacement as noted in Section 1.12.A.1. Contractor shall repair installed equipment on the job site to Owner's satisfaction. For any time during said guarantee period that fixtures are not fully functional due to defects in material or workmanship, Contractor shall provide or pay for suitable temporary light fixtures, and shall remove said temporary fixtures upon installation of replacement elements. Contractor shall furthermore guarantee replacement fixtures for a period of one year following replacement.
- B. Contractor shall not be held responsible for damage of fixtures or equipment components occurring after the beginning of the guarantee period due to acts of vandalism, acts of war, or acts of God.
- C. LED Warranties: Shall be free from defects in materials and workmanship for the period indicated from date of factory shipment.
 - 1. LED Luminaires, including LED modules, arrays and drivers: Five years.
 - 2. LED Lamps: Three years.
- D. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for Light fixtures: Free from defects in materials and workmanship (excluding fuses and lamps) for a period of 3 years from date of Substantial Completion.

2. Warranty Period for Metal Corrosion: Free from defects in materials and workmanship for a period of 2 years from date of Substantial Completion.
3. Warranty Period for Color Retention: Free of fading for a period of 2 years from date of Substantial Completion.
4. Warranty Period for Poles: Repair or replace light poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than 3 years from date of Substantial Completion.
5. Alignment Warranty: Accuracy of alignment of light fixtures shall remain within specified illuminance uniformity ratios for a period of 2 years from date of successful completion of acceptance tests. Realign fixtures that become misaligned during the warranty period. Replace alignment products that fail within the warranty period. Retest distribution to verify proper realignment.
6. Warranty for Pole-Mounted LED Area Lights: Light fixture (including LEDs and drivers) and pole will be free of defects in material and workmanship for a period of ten years from date of product purchase.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch deep. Do not apply tools to section of pole to be installed below ground line.
- D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation.
- E. Retain factory-applied pole wrappings on metal poles until right before pole installation.
- F. Handle all poles with web fabric straps.

1.11 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Additional light fixtures, poles, and accessories as scheduled on the Drawings.
- B. Where light fixtures are specified with tamper proof hardware, provide the Owner with three tools for each different type of hardware.

1.12 SPARES

- A. Furnish spare materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Glass and Plastic Lenses, Covers, and Other Optical Parts: 5 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Drivers: 2 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Globes and Guards: 2 for every 50 of each type and rating installed. Furnish at least one of each type.
 - 4. Fuses: 10 for every 100 of each type and rating installed.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

- A. In Light Fixture Schedule (on the drawings) where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 LIGHT FIXTURES, GENERAL REQUIREMENTS

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

- H. Exposed Hardware Material: Stainless steel for latches, fasteners, and hinges.
- I. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- J. Light Shields: Metal baffles or louvers, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- K. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- L. Gaskets for Lenses and Refractors: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in light fixture doors.
- M. Where located within structural concrete, light fixture housing and any other luminaire components in direct contact with concrete shall be effectively coated and/or covered to prevent chemical reactions with the concrete in accordance with the American Concrete Institute Code.
- N. Light Fixture Finish: Manufacturer's standard paint applied to factory-assembled and -tested light fixture before shipping. Where indicated, match finish process and color of pole or support materials.
- O. Factory-Applied Finish for Steel Light Fixtures: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As indicated on the Light Fixture Schedule.
- P. Factory-Applied Finish for Aluminum Light Fixtures: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 - 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - a. Color: As indicated on the Light Fixture Schedule.
- Q. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps, LEDs and/or drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 1. Label shall include the following lamp, LEDs, ballast and/or driver characteristics:
 - a. "USES ONLY" and include specific or LED type.
 - b. .
 - c. LED type, wattage, beam angle (if applicable) for LED luminaires. Include maximum allowed wattage.
 - d. For LED luminaires, includes CCT and CRI.

2.3 DRIVERS FOR LED LUMINAIRES

- A. Description: Designed for type and quantity of LED diodes of light fixture. Drivers shall tolerate sustained open circuit and short circuit output conditions without damage. Driver shall be designed for full light output unless dimmer or bi-level control is indicated:
 1. Sound Rating: A.
 2. Total Harmonic Distortion Rating: Less than 20 percent. Shall comply with ANSI C82.77.
 3. Transient Voltage Protection: IEEE C62.41, Category A or better.
 4. Power Factor: 0.90 or higher at full load.
 5. Interference: Comply with 47 CFR, Chapter 1, Part 15, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
 6. Driver shall operate with maximum sustained variations of +/- 10% input voltage and frequency with no damage to driver.
 7. Driver output shall be regulated to +/- 5% published load range.
 8. LED Current Crest Factor: 1.5 or less.
 9. LED drivers shall not over-drive LEDs at a current or voltage above LED rated values in order to increase LED lumen output.
 10. Meets EN610000 for input harmonics.

11. ROHS Compliant.
12. Suitable for use in outdoor light fixtures.
13. Dimming Drivers
 - a. Dimming Range: Visually flicker-free, strobe-free, continuous dimming of source as follows, unless specifically noted otherwise in the Light Fixture Schedule whichever is more stringent:
 - 2) Luminaires: 100 to 10 percent of rated lumens.
 - 3) LED Lamps: 100 to 20 percent of rated lumens.
 - b. 0-10V dimming drivers: Compliant with IEC 60929 standard for 4-wire dimming.
 - c. Compatibility: Certified by the manufacturer for use with specific dimming control system and LED indicated.
 - d. Control: Coordinate to ensure that the dimming driver, power supply, controller, dimming module, and/or wallbox dimmer and connecting wiring are compatible.

2.4 LED LAMPS AND LUMINAIRES

- A. Comply with ANSI C78.377 for white light LED color range. Unless noted otherwise in the Light Fixture Schedule, LED color quality characteristics shall be 70 CRI minimum and 4000K CCT. Additionally, color-important light fixtures, as indicated with 80 CRI or better the Light Fixture Schedule shall be 80 CRI minimum and 4000K CCT. All LEDs used for same fixture type throughout the project to originate from same production bin.
- B. LED binning specification tolerance to be within 3 MacAdam ellipses of rated values for color as indicated in the Light Fixture Schedule.
- C. Unless indicated otherwise in the Light Fixture Schedule, minimum 70% of maintained initial-rated lumens at the average rated life as follows:
 1. LED outdoor pole mounted area lights: 100,000 hours
 2. LED lamps: 20,000 hours
 3. Other LED luminaires: 50,000 hours
- D. ROHS compliant
- E. Manufacturer of LED chips will be evaluated based on the manufacturer's product literature and data. At a minimum, LED fixtures or lamps will incorporate Bridgelux, Nichia, Cree, Xicato or Osram LEDs; additional manufacturers may be considered however the Architect or Engineer has the authority to reject other manufacturers for technical or aesthetic reasons if felt necessary or desirable.

2.5 AUXILIARY DEVICES FOR LOW VOLTAGE AND LED FIXTURES

- A. Provide remote power supplies, drivers and/or transformers for light fixtures as required for a complete and operational system.

2.6 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.
 - 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article.
 - 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of light fixtures and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Light Fixture Attachment Provisions: Comply with light fixture manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 - 1. Materials: Shall not cause galvanic action at contact points.
 - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, complying with ASTM A 123/A 123M or ASTM A 153/A 153M unless stainless-steel items are indicated.
 - 3. Anchor-Bolt Template: Plywood or steel.
- D. Concrete Pole Foundations: Cast in place, 3000-psi (28-day minimum compressive strength, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, light fixture(s), and accessories.
- F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

2.7 STEEL POLES

- A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; 1-piece construction up to 40 feet in height with access handhole in pole wall.
 - 1. Shape: As indicated in the Light Fixture Schedule.

2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Steel Mast Arms: As indicated in the Light Fixture Schedule type, continuously welded to pole attachment plate. Material and finish same as pole.
- C. Brackets for Light Fixtures: Detachable, cantilever, without underbrace.
 1. Adapter fitting welded to pole and bracket, then bolted together with galvanized-steel bolts.
 2. Cross Section: Tapered oval, with straight tubular end section to accommodate light fixture.
 3. Match pole material and finish.
- D. Pole-Top Tenons: Fabricated to support light fixture or light fixtures and brackets indicated, and securely fastened to pole top.
- E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet above finished grade.
- F. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.
- G. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- H. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
- I. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- J. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.
- K. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
 3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected by Architect from manufacturer's full range
 - 4.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify conditions of equipment and installation prior to beginning work.
- B. Verify that equipment is ready for connecting, wiring, and energizing.

3.2 LIGHT FIXTURE INSTALLATION

- A. Fasten light fixture to indicated structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- B. Adjust light fixtures that require field adjustment or aiming.
- C. Baffles and Louvers for Spill Light Correction: Install on lighting fixtures with fasteners provided by the manufacturer. Install and adjust to correct out-of-limit spill-light and glare measurements.
- D. Install controls or driver housings in cabinets mounted on support structure at least 10 feet above finished grade.
- E. Auxiliary devices for low voltage and LED fixtures installation
 - 1. Install device within maximum remote distances and with wiring sized per manufacturer's recommendations.
 - 2. In public areas or other areas where remote device visibility is undesirable, install device where concealed from view, well-ventilated and accessible. Provide access panels as required.
 - 3. Provide label on device indicating fixture type and location/room served along with panelboard circuit number.
 - 4. Properly support remote lighting devices, including, but not limited to, transformers, power supplies, and drivers, per Code and manufacturer's recommendations.
 - 5. Provide enclosures suitable for installation environment as required.

3.3 DIMMING

- A. For dimmable light fixtures, provide both control and power wiring between light fixture and control device and between light fixtures. Quantity of low voltage and line voltage wiring and wire type shall be per manufacturer's recommendations. At a minimum, provide the following based on control type at either 120V or 277V, unless recommended otherwise by the manufacturer:
 - 1. 0-10V – two low voltage conductors and two line voltage conductors plus ground
 - 2. DALI – two low voltage conductors and two line voltage conductors plus ground

3. Proprietary digitally addressable – as required per the manufacturer
- B. Coordinate light fixture and control device dimming types for compatibility.

3.4 POLE INSTALLATION

- A. Align pole foundations and poles for optimum directional alignment of light fixtures and their mounting provisions on the pole. Install poles and other structural units level, plumb, and square.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
 1. Fire Hydrants and Storm Drainage Piping: 60 inches.
 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
 3. Trees: 15 feet.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space. Grout materials, installation, and finishing requirements are specified in Division 05 Section "Metal Fabrications".
 3. Install base covers, unless otherwise indicated.
 4. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
 1. Dig holes large enough to permit use of tampers in the full depth of hole.
 2. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
- F. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
 1. Make holes 6 inches in diameter larger than pole diameter.

2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days, and finish in a dome above finished grade.
 3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
 4. Cure concrete a minimum of 72 hours before performing work on pole.
- G. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.
- H. Raise and set poles using web fabric slings (not chain or cable).

3.5 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LIGHT FIXTURES

- A. Install on concrete base with top 4 inches <Insert height> above finished grade or surface at light fixture location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.6 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 26 Section "Raceways and Boxes for Electrical Systems", including use of coated conduits in concrete foundations.

3.7 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
1. Install grounding electrode for each pole, unless otherwise indicated.
 2. Install grounding conductor pigtail in the base for connecting light fixture to grounding system.
- B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
1. Install grounding electrode for each pole.
 2. Install grounding conductor and conductor protector.
 3. Ground metallic components of pole accessories and foundations.

3.8 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Adjust all light fixture sockets to match the lamp specified and aim all adjustable light fixtures as directed by the Architect.
- C. Upon completion of the installation of light fixtures, and after building circuits have been energized, apply electrical energy to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- D. Clean light fixtures of dirt and debris upon completion of the installation. Protect installed light fixtures from damage during the remainder of the construction period.
- E. At the time of Substantial Completion, aim all adjustable fixtures, such as flood and spot lights, per the Architect's direction. Provide all necessary equipment to support this effort, such as scaffolds and lifts, as required.
- F. At the time of Final Acceptance of this Project by the Owner, all lamps shall be in working order and all light fixtures shall be fully lamped.
- G. Illumination Observations: Verify normal operation of lighting units after installing light fixtures and energizing circuits with normal power source.
 - 1. Verify operation of parking lot dimming controls.
- H. Illumination Tests Areas other than Sports Playing Fields:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
 - a. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
 - b. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
 - c. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - d. IESNA LM-72, "Directional Positioning of Photometric Data."
 - e. .
- I. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.9 CORRECTION OF DEFICIENCIES

- A. Correction of Illumination Deficiencies: Make corrections to illumination quality or quantity measured in field quality-control tests that vary from specified illumination criteria by plus or minus 10 percent or more; add or replace lighting fixtures, or change mounting height, revise aiming, or install louvers, shields, or baffles. If lighting fixtures are added or mounting height is changed, revise aiming and

recalculate and modify or replace support structures, if indicated. Retest as specified above after repairs, adjustments, or replacements are made. Report results in writing.

- B. Correction of Excessive Illumination in Spill-Light-critical Areas: If measurements indicate that specified limits for spill light are exceeded, make corrections to illumination quantity measured in field quality-control tests that reduce levels to within specified maximum values. Replace lighting fixtures, or change mounting heights, revise aiming, or install louvers, shields, or baffles. Obtain Architect's approval to replace luminaires with units of higher or lower wattage. If mounting height is changed, revise aiming and recalculate and modify or replace support structures, if indicated. Retest as specified above after repairs, adjustments, or replacements are made. Report results in writing.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain light fixtures . Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 265668 - EXTERIOR ATHLETIC FIELD LIGHTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. The following specifications detail the minimum performance and related criteria for illumination of the exterior athletic playing surfaces and associated spectator areas including luminaires, poles, support and mounting components, and accessories. Any deviations from this specification must be documented in writing and submitted to the Engineer for approval, in addition to the submittal requirements listed in this document.
- B. System Design: The Contractor shall perform all calculations and develop all plan and detail drawings required, in conjunction with these specifications, for installation of a complete and operational athletic field lighting system.

1.2 DEFINITIONS

- A. Athletic Field: Area of athletic play, including but not limited to the playing surface, sidelines, run-off areas, team areas, and coaching boxes.
- B. Athletic Field Lighting System: Lighting control system intended to illuminate Athletic Field, Spectator Areas, and other areas as indicated utilizing high-out, amiable luminaires. System includes luminaires, lamps, ballast, drivers, support structures, wiring, controls and other components required for a complete and operating system.
- C. BF: Ballast factor.
- D. CRI: Color-rendering index.
- E. CU: Coefficient of utilization.
- F. CV: Coefficient of Variation; a statistical measure of the weighted average of all relevant illumination values for the playing area, expressed as the ratio of the standard deviation for all illuminance values to the mean illuminance value.
- G. Delegated-Design Submittals: Documents, including drawings, calculations, and material and product specifications prepared as a responsibility of Contractor to obtain acceptance by Owner and Authorities Having Jurisdiction.
- H. Illuminance: The density of luminous flux, or flow of light, reaching a surface divided by the area of that surface.
 - 1. Horizontal Illuminance: Measurement in foot-candles (lux), on a horizontal surface 36 inches (915 mm) above the ground, unless otherwise indicated.

2. Vertical Illuminance: Measurement in foot-candles (lux) on a vertical surface at an elevation coinciding with plane height of horizontal measurements.
- I. HID: High-intensity discharge.
- J. LED: Light Emitting Diode.
- K. LER: Light fixture efficacy rating.
- L. Light fixture: Used interchangeably in this section with “Luminaire.”
- M. Light Trespass: Light spill into areas and properties outside the playing areas, which is either annoying or unwanted.
- N. LLD: Lamp Lumen Depreciation, which is the decrease in lamp output as the lamp ages.
- O. LLF: Light Loss Factor, which is the product of all factors that contribute to light loss of the system.
- P. Luminaire: Complete lighting fixture.
- Q. NRTL: National Recognized Testing Laboratory.
- R. NVLAP: National Voluntary Laboratory Accreditation Program.
- S. Playing Surface: Area of athletic play such as the field, court, pool, track, or pitch.
- T. Pole: Light fixture support structure, including tower used for large area illumination.
- U. Spectator Area: Seating and egress areas designed for spectators adjacent to and facing the Playing Surface, including but not limited to grand stands, seating bowls, walkways, and aisles.
- V. Support Structure: Free-standing or building mounted structure used for support and mounting of luminaires and accessories. Includes but is not limited to poles, masts, towers, and truss systems.
- W. Target Illumination: Average maintained illumination level, calculated by multiplying initial illuminance by LLF.
- X. UG: Uniformity Gradient; the rate of change of illuminance on the playing field, expressed as a ratio between the illuminances of adjacent measuring points on a uniform grid.

1.3 SUBMITTALS

- A. General:
 1. Submit all components of the exterior athletic field lighting system specified for use on this Project, in a single submittal package of portfolios, so that all components can be reviewed at one time.
 2. Prepare portfolios from manufacturer's standard specification sheets and identify each component. Do not combine more than one component on a single sheet.

3. Submit Shop Drawings as required by Division 1.
- B. Product Data: For each luminaire and support/mounting component, arranged in order of luminaire designation. Include data on features, accessories, finishes, and the following:
1. Name of manufacturer.
 2. Descriptive cut sheets providing physical description of luminaire including materials, dimensions, effective projected area, and verification of indicated parameters.
 - a. Fixture efficacy.
 - b. Coefficient of utilization tables.
 - c. Light fixture voltage.
 - d. The number, type and wattage of the light fixture lamps (including product data, where applicable).
 - e. Lens type (if applicable).
 3. Light fixture options that are to be provided.
 4. Details of attaching light fixtures, mounting and accessories.
 5. Construction of light fixture housing and door (if applicable).
 6. Driver cut sheet with options marked, providing physical description of ballast including, but not limited to, voltage, lamp, ballast factor, power factor, amperage and wattage. Include energy-efficiency data (if applicable).
 7. Light fixture finish and color (if applicable).
 8. Life, output, and energy-efficiency data for lamps. Lamp data certified by NVLAP, or NRTL. Energy data shall comply with IESNA LM-47.
 9. Details of installation and construction.
 10. Photometric data based on laboratory tests of each light fixture type, complete with indicated lamps, ballasts, and accessories. Comply with IESNA LM-5.
 - a. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 11. Dimensions, and finishes of poles/light fixture supports. Means of attaching light fixtures to supports, and indication that attachment is suitable for components involved.
- C. Delegated-Design Submittals: For exterior athletic lighting indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation:

1. Drawings and specifications for construction of the athletic field lighting system.
 2. Manufacturer's determination of LLF used in design calculations. Lighting calculations shall include a LLF of 0.70 . Provide a list of recoverable and non-recoverable LLFs used in the submitted calculations for review by the Engineer.
 3. Manufacturer Cut-sheets: For support structures, including mounting brackets, arms, appurtenances, bases, anchorages, and foundations from manufacturer.
 4. Design calculations for the following:
 - a. Illumination Calculations: Computer-analyzed point method complying with IESNA RP-6 to optimize selection, location, and aiming of luminaires. Scans for both initial and maintained light levels shall be submitted along with the specified spill light calculations. Provide maintained light level calculations for systems utilizing Constant Light Technology or similar system.
 - b. Target illuminance.
 - 1) Point Calculations of horizontal and vertical illuminance, CV, and UG at minimum grid size and area.
 5. Electrical system design calculations for the following:
 - a. Short-circuit current calculations for rating of panelboards, where applicable.
 - b. Total connected and estimated peak-demand electrical load, in kilowatts, of lighting system.
 - c. Ampacity requirements of feeder required to supply the lighting system.
 6. Wiring requirements, including required conductors and cables and wiring methods.
 7. Structural analysis data and calculations used for pole and support structure selections.
 - a. Manufacturer Wind-Load Strength Certification: Submit certification that selected total support system, including poles, complies with AASHTO LTS-4 or as noted elsewhere in this specification for location of project.
- D. Informational Submittals:
1. Shop Drawings:
 - a. Wiring Diagrams: Power and control wiring.
 - b. Aiming Diagrams: Playing surface and spectator area plans showing aiming points for light fixtures.
 2. Qualification Data: For qualified Installer, manufacturer, luminaire photometric data testing laboratory, and field testing agency.

- E. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 or as noted elsewhere in this specification and that loads imposed by light fixtures and attachments have been included in design. This certification shall be based on design calculations by a Professional Engineer.
- F. Field quality-control reports.
- G. Operation and Maintenance Data: For light fixtures, support structures, and mounting equipment to include in operation and maintenance manuals.
- H. Warranty: Sample of special warranties specified in this Section.

1.4 SUBSTITUTIONS

- A. Refer to Division 26 Section “General Electrical Requirements”.
- B. Prior to the Bid Date, substitutions will not be considered unless the Architect/Engineer have received written request for approval at least ten calendar days prior to the date for receipt of Bids. Include in each such request the fixture designation, name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including cut sheets, photometric data, and all other information necessary for an evaluation. Provide point-by-point calculations meeting Delegated Design requirements noted above. Submit a \$100.00 review fee to the Engineer with each such point-by-point calculation for use of electronic base files. The fee will be returned if the substitution is added to the specification.
- C. After the Bid Date, proposals to substitute light fixtures for those shown on the Drawings or specified herein, will only be considered as a deduct. Submit proposed substitutions separately, in Submittal form, with a list of proposed substitutions together with a deduct price for each substitution. Proposed substitutions will then be reviewed by the Architect/Engineer.
- D. The Architect/Engineer have the final authority as to whether the light fixture is an acceptable replacement to the specified item. The proposed substitution may also be rejected for aesthetic reasons if felt necessary or desirable. In the event the proposed substitutions herein described are rejected, provide the specified item(s).

1.5 PERFORMANCE REQUIREMENTS

- A. Facility Type: High school.
- B. Illumination Criteria:
 - 1. Athletic Playing surface type: Football Baseball and Softball.
 - a. IESNA RP-6, Class of Play: Class II.
 - b. Speed of Sport: Moderate
 - c. Athletic organization standard: Missouri State High School Activities Association, Non-Televised Event.

2. Performance Requirements:

- a. Athletic Playing Surfaces and Spectator Areas shall be lit to the levels specified in the charts below. Manufacturer shall provide computer models guaranteeing average maintained light levels on the field and spectator areas for the length of the warranty.

Athletic Playing Surface Illumination Criteria

Area of Lighting	Target Illumination (Horizontal)	Maximum to Minimum Uniformity Ratio (Horizontal & Vertical)		Grid Spacing
Playing Surface	100 fc infield	1.5:1.0	infield	30'x30'
	75 fc outfield	2.0:1.0	outfield	

Spectator Area Illumination Criteria

Area of Lighting	Target Illumination (Horizontal)	Minimum Illumination (Horizontal)	Maximum to Minimum Uniformity Ratio (Horizontal)	Grid Spacing
Seating Area	5 fc	1 fc	5:1	10'x10'

3. Recoverable Light Loss Factor of 0.70 for LED, per recommendations from the IES shall be applied to the initial light level design to achieve the maintained light levels listed above. Lighting Systems that use the IESNA recognized time power adjustments (IESNA 10th edition handbook) will be acceptable and must achieve the specified Target Illumination. Lighting calculations shall be developed based on the grid spacing as specified in the chart above.
4. Measured average illumination level shall meet or exceed the requirements listed above, be +/- 10% of predicted mean in accordance with IESNA RP-6-01, and measured at the first 100 hours of operation. If measured initial average illumination levels in manufacturer's submittals cannot be met additional fixtures shall be added to meet the requirements at no additional cost to the Owner. Increases to electrical distribution system including but not limited to additional panelboards, transformers, circuit breakers, feeders, and branch circuits caused by additional fixtures shall also be provided at no additional cost to the Owner.
5. CV and maximum-to-minimum uniformity ratios for each lighted area shall be equal to or less than those listed in IESNA RP-6 for the indicated class of play.
6. UG levels within each lighted area equal to or less than those listed in IESNA RP-6 for the indicated speed of sport.
7. Lighting shall be directed at the playing surface and spectator areas.
8. Spill-Light control: Minimize spill light for playing area on adjacent and nearby areas.

- a. Prevent light trespass on properties near Project as defined by Authorities Having Jurisdiction.
 - b. For areas indicated on the Drawings as “spill-light critical,” limit the level of illuminance directed into the area from any luminaire or group of luminaires, and measured 36 inches above grade to the following:
 - 1) Maximum Horizontal Illuminance: 0.5 fc.
 - 2) Maximum Vertical Illuminance from the direction of the greatest contribution of light: 2.0 fc.
 - c. Calculate the horizontal and vertical illuminance due to spill light for points spaced 20 feet.
9. Glare Control: Design illumination for each playing area to minimize direct glare in adjacent and nearby areas.
- a. Design source intensity of luminaires that may be observed at an elevation of 60 inches or higher above finished grade from nearby properties to be less than 12,000 candela when so observed.
 - b. Design source intensity of luminaires that may be observed at an elevation of 60 inches or higher above finished grade from designated “spill-light critical” areas to be less than 12,000 candela when so observed.]
- C. Illumination Calculations: Computer-analyzed point method complying with IESNA RP-6 to optimize selection, location, and aiming of luminaires. Scans for both initial and maintained light levels shall be submitted with the bid.
1. Grid Pattern Dimensions: For playing areas of each sport and areas of concern for spill-light control, correlate and reference calculated parameters to the grid areas and intersection points of the indicated grid pattern. Grid Spacing specified charts above.
 2. Building reflectance shall not be included in the lighting design calculations.
 3. Determine LLF according to IESNA RP-6 and manufacturer's test data.
 - a. Use LLD at 70 percent of rated lamp life for LED lamp sources. LLF shall be applied to initial illumination to ensure that target illumination is achieved at 100 percent of lamp life and shall include consideration of field factor.
 - b. LLF shall not be higher than 70 percent, and may be lower when determined by manufacturer after application of the ballast output and optical system output according to IESNA RP-6.
 4. Use a field factor of 15 percent according to IESNA RP-6, in establishing initial illuminance.
 5. Light Fixture Mounting Height: Comply with recommendations in IESNA RP-6, with consideration for requirements to minimize spill light and glare.

6. Luminaire Placement: Luminaire clusters shall be outside of glare zones defined by IESNA RP-6.

D. Electrical Power Distribution Requirements:

1. Electrical power available for Athletic Field Lighting System:
 - a. Normal Power: 480Y/277 volts, three phase, four wire.
2. Include roughing-in of service indicated for non-sports improvements on the Project site.
3. Balance load between phases. Install wiring to balance three phases at each support structure.
4. Include required overcurrent protective devices and individual lighting control for sports field or venue.
5. Include indicated feeder capacity and panelboard provisions for future lighted sports field construction.
6. Maximum Total Load: 200 amperes.
7. Maximum Total Voltage Drop from Source to Load: 5 percent, including voltage drops in branch circuit, subfeeder, and feeder.

E. Lighting Controls System: Manual, low voltage, or digital; providing the following functions, integrated into a single control station.

1. Control Station: Key-operated master switch.
2. Control Zones: Provide multiple levels of control as indicated below. Each level of control shall have a dedicated switch labeled with the zone it controls. Provide an additional master control switch that turns all zones on and off via a single switch.
 - a. Playing Field: Provide one level of control for all luminaires aimed at the playing field.
 - b. Playing Field: Provide two levels of control for all luminaires aimed at the playing field. The first level shall provide 75 percent illumination and the second shall provide 25 percent illumination over the playing surface. Both levels shall provide uniform lighting over the playing surface.
 - c. Spectator Areas: Provide one level of control for all luminaires aimed at spectator seating areas.

1.6 POWER DISTRIBUTION AND CONTROL

A. Wiring Method for Subfeeders, Branch Circuits, and Control Wiring:

1. Non-metallic raceway as specified within other sections or drawings; No. 10 AWG copper minimum conductor size for power wiring.

- B. Overhead-, pole-, or structure-supported wiring and transformers are not permitted.
- C. Electrical Enclosures Exposed to Weather: NEMA 250, Type 3R enclosure constructed from stainless steel, with hinged doors fitted with padlock hasps or lockable latches.
- D. All wiring for emergency luminaires shall be run in separate raceways from the normal lighting circuits.
- E. The circuit conductors, feeders, circuit breakers to lighting poles indicated are based on preliminary lighting system designs from the basis of design manufacturer. The final number of branch circuit/feeder conductors, the sizes of the branch circuit/feeder conductors, number of circuit breakers, sizes of circuit breakers and other system components required to provide a complete functioning lighting system shall be provided and included within the Contractor's bid based the final lighting system design that meets the illumination requirements specified herein and on the drawings.
- F. Voltage drop shall be considered for all branch/feeder conductors. Engineer may request a submittal for all voltage drop calculations for the lighting power distribution system.

1.7 STRUCTURAL ANALYSIS CRITERIA FOR SUPPORT STRUCTURE SELECTION

- A. Dead Load: Weight of light fixture and its horizontal and vertical supports, and supporting structure, applied as stated in AASHTO LTS-4.
- B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4.
- C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4.
- D. Wind Load: Pressure of wind on support structure and light fixture, calculated and applied as stated in AASHTO LTS-4.
 - 1. Wind speed for calculating wind load for support structure exceeding 50 feet in height is 70 mph.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this project.
- B. Manufacturer Qualifications: Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Manufacturer's responsibilities include fabricating sports lighting and providing professional engineering services needed to assume engineering responsibility.
 - 1. Engineering Responsibility: Preparation of delegated-design submittals and comprehensive engineering analysis by a qualified Professional Engineer.
 - 2. Manufacturer shall be capable of providing "Turn-Key" services to Contractor which include delegated design of all components of the athletic field lighting system, including but not

limited to luminaires, support structure locations and design, photometric calculations, and lighting control system requirements. Manufacturer shall furnish and install all components of the athletic field lighting system required for a complete and operating system. General and Electrical Contractor shall furnish and install feeders and branch circuit conduits and conductors from the building to the connection point(s) indicated in the Manufacturer's Delegated Design documents.

- D. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the NVLAP Program for Energy Efficient Lighting Products.
- E. Light Fixture Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- F. 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.
- G. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel" and AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
- H. Comply with IEEE C2, "National Electrical Safety Code."
- I. Comply with NFPA 70 National Electrical Code (NEC).

1.9 FIELD VERIFICATION

- A. All testing and computer analysis shall generate values based upon the grid size and number of target points referenced in Illumination per LM-5, the IESNA guide for photometric testing of area and sports lighting installations as indicated below:

Area of Lighting	Grid Size	Min. No. of Test Points
Baseball – Infield	30'x30'	25
Baseball – Outfield	30'x30'	130
Softball – Infield	30'x30'	25
Softball – Outfield	30'x30'	98

- B. Playing Surface and Spectator Area Measurements:

1. Horizontal footcandles (fc): The light meter shall be in a horizontal position 36" above the playing surface. The cell of the meter shall be self-leveling and mounted on a tri-pod.
2. Vertical footcandles (fc) the light meter shall be in a vertical position 36" above the playing surface pointed toward each field camera positions indicated in the Performance Requirements Table above.
3. These readings shall be taken with the Owner or their representative present.

- C. Evaluation Procedures

1. All luminaires shall be operating and properly aimed.
 2. All lamps shall have been in operation for at least 100 hours prior to testing. If the lamps and/or luminaires have been in operation for more than 100 hours, the approximate operating hours shall be recorded.
 3. The system shall be operating for at least 30 minutes prior to testing to allow for lamp stabilization.
 4. Testing shall be done when the air and sky are clear and extraneous light is at a minimum.
 5. The test personnel shall take all possible precautions not to cast shadows or reflect light from items such as clothing, PPE, or measurement instruments.
 6. The test personnel shall use a light meter that has been calibrated within 12 months of the test. The light meter shall have been calibrated to the lamp type or light source being used.
 7. A variation between computer generated performance and field measured results is expected. Field measured results shall be within plus or minus 10% of the predicted computer generated results.
- D. Prior to Project completion, the manufacturer's representative shall provide a final report from the test results that shall provide the following items:
1. Name of installation.
 2. Date and time of the test.
 3. Description of the weather.
 4. Description of the lighting system. This shall include the number and types of luminaire for each location, the mounting heights, and lamp manufacture and type, and other pertinent details.
 5. Type, make, model, serial number, and copy of calibration certificate for the light meter used. Light meter must display to the 0.01.
 6. Identification of number and location of test grid.
 7. Actual horizontal and vertical footcandle readings taken at each test point.
 8. Average illumination levels.
 9. Maximum to minimum ratios.
 10. Coefficient of Variation.
 11. Uniformity Gradient.

1.10 COORDINATION

- A. Unless otherwise noted, perform all electrical work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other Divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

1.11 WARRANTY & MAINTENANCE SERVICE

- A. 10-Year Warranty: Each manufacturer shall supply a signed warranty which shall include all parts, labor and equipment necessary to maintain the system for 10 years and shall include: all lamp replacements; guaranteed minimum light levels; routine maintenance.
 - 1. Warranty may exclude fuses, impact damage, vandalism, abuse and unauthorized repairs or alterations.
- B. Special Warranty: Include a full service product assurance and warranty program providing trouble-free lighting equipment operation, including parts and labor as well as group lamp replacements as often as required during the term of the warranty to ensure minimum lighting design levels are maintained each season.
 - 1. Warranty Period for Light fixtures: Free from defects in materials and workmanship (excluding fuses and lamps) for a period of 10 years from date of Substantial Completion.
 - 2. Warranty Period for Lamps: Replace lamps and fuses that fail within the terms of the warranty agreement for a period of 5 years.
 - 3. Warranty Period for Poles: Repair or replace light poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than 10 years from date of Substantial Completion.
- C. The fixture crossarm shall be warranted (Limited Warranty) for a period of 10 years and warrants to the purchaser that all assembly(s) shall be free from defects in materials and workmanship from the date of shipment. A copy of the manufacturer's warranty shall be submitted to the Owner.
- D. Alignment Warranty: Accuracy of alignment of light fixtures shall remain within specified illuminance uniformity ratios for a period of 10 years from date of successful completion of acceptance tests. Realign fixtures that become misaligned during the warranty period. Replace alignment products that fail within the warranty period. Retest distribution to verify proper realignment.
- E. Preventative and Spot Maintenance: Manufacturer shall provide all preventative and spot maintenance, including parts and labor for 10 years from the date of equipment shipment. Per IES individual lamp outages shall be repaired when the outage causes the light on the field to drop below 10% of the maintained light levels or when a fixture outage, at Owner's discretion, materially impacts safety and/or playability of the field. Owner agrees to check fuses in the event of a luminaire outage.
- F. Services: Repair or replace components of luminaires, lamps, and ballasts; align luminaires. Provide lifting equipment as required.

1.12 SPARES

- A. Furnish spare materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. LED Boards – For LED light fixtures with LED boards that are field replaceable by electricians or non-factory technicians, 10% of each type and optical distribution of LED boards installed. Furnish at least two of each type.
 - 2. Light Fixtures – For LED light fixtures with LED boards that require factory technician replacement either at the factory or on-site, 10% of each light fixture type with different optical distributions installed. Furnish at least two of each type.
 - 3. Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Ballasts and/or Drivers: 5 for every 100 of each type and rating installed. Furnish at least two of each type.
 - 5. Visors and Shields: 2 for every 100 of each type and rating installed. Furnish at least one of each type.

1.13 DELIVERY, STORAGE, AND HANDLING

- A. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- B. Handle all poles with web fabric straps.

PART 2 - PRODUCTS AND MATERIALS

2.1 ATHLETIC LIGHTING SYSTEM REQUIREMENTS

- A. Base bid:
 - 1. LED luminaires, Missouri State High School Activates Association and IES light lighting standards.
 - a. Number of Poles: As indicated on the Drawings

2.2 MANUFACTURERS

- A. Basis-of-Design Product: The design for each light fixture is based on the product indicated in the Light Fixture Schedule or elsewhere on the Drawings. Subject to compliance with requirements, provide either the named product or a comparable product by one of the following manufacturers that meets or exceeds performance characteristics of the named product:
 - 1. Ephesus

2. Musco

- B. Substitutions of comparable products must provide a complete submittal package as outlined in this section for Engineer review at least (10) days prior to bid.
 - 1. Acceptance of a substitution does not negate the Contractor and lighting manufacturer's responsibility to comply fully with the requirements of these specifications. Any exceptions to the specifications must be clearly stated in the prior approval submittal documents.

2.3 LUMINAIRES – LED, GENERAL REQUIREMENTS

- A. Luminaires: Listed and labeled, by an NRTL acceptable to Authorities Having Jurisdiction, for compliance with UL 1598 for installation in wet locations.
 - 1. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without using tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent their accidental falling during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lens.
 - 2. Exposed Hardware: Stainless-steel latches, fasteners, and hinges.
 - 3. Spill-Light Control Devices: Internal lenses, internal louvers, or external baffles furnished by manufacturer and designed for secure attachment to specific luminaire.
 - 4. All luminaires shall be constructed with a die-cast aluminum housing to protect the luminaire system.
 - 5. Luminaires shall be bracket-mounted, full-cutoff type with remote or integral drivers.
- B. Remote Driver Mounting: Grouped in cabinets, in enclosures mounted with bottom of enclosure at a minimum of 10'-0" <insert value> above finish grade. The enclosures shall include drivers and safety disconnect switches. One disconnect switch shall be provided per circuit for each pole structure. Access panels shall be provided as necessary and required.
- C. Luminaires shall be provided with aiming devices, degree scale and position locks. Luminaires shall be factory marked to correspond with proper pole, position on pole, and aiming angles.
- D. For safety, the entire system shall be NRTL Listed as a complete system.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Formed and supported to prevent warping and sagging.
- G. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed light fixtures.

- H. Light Shields: Metal baffles, louvers, or lenses, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field. Provide as applicable per AHJ requirements.
- I. Gaskets for Lenses and Refractors: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in light fixture doors.
- J. Light Fixture Finish: Manufacturer's standard paint applied to factory-assembled and -tested light fixture before shipping. Where indicated, match finish process and color of pole or support materials.
 - 1. Factory-Applied Finish for Steel Light Fixtures: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - a. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - b. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - c. Color: As indicated on the Light Fixture Schedule.
 - 2. Factory-Applied Finish for Aluminum Light Fixtures: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - a. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - b. Color: Manufacturer's standard color.
 - c. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 - d.
- K. LED Lamp Technology
 - 1. Minimum L70 of 100,000 hour lamp life, instant on/off and dimming capabilities.
 - 2. Color Temperature: As indicated on the Light Fixture Schedule.
 - 3. Color Rendering: As indicated on the Light Fixture Schedule
 - 4. Maximum of 115,000 initial delivered fixture lumens to minimize glare potential.

5. Fixture Operating Temperature Range of -30 Degrees C to 55 Degrees C. Maximum Junction Temperature for the diodes of 80 Degrees C
6. Flicker of $\leq 2\%$.

2.4 POLES AND SUPPORT COMPONENTS - GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.
 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Poles Selection" Article, with a gust factor of 1.3.
 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of light fixtures and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Light Fixture Attachment Provisions: Comply with light fixture manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

2.5 SUPPORT STRUCTURE (STEEL POLES)

- A. Support-Structure Wind-Load Strength: Project specific pole/structure drawings stamped by a Professional Engineer licensed in the state where the project is located are required. The poles/structure shall be designed to meet or exceed the current local structural code(s) and all pertinent AASHTO Standards. Poles and other support structures, brackets, arms, appurtenances, bases, anchorages, and foundations shall comply with AASHTO LTS-4-M Design requirements for wind speed, exposure category, and importance factor shall be documented in design and calculations.
 1. Dead Load: Weight of light fixture and its horizontal and vertical supports, and supporting structure, applied as stated in AASHTO LTS-4.
 2. Live Load: Single load, distributed as stated in AASHTO LTS-4.
 3. Ice Load: Applied as stated in AASHTO LTS-4.
 4. Wind Load: Pressure of wind on pole and light fixture, calculated and applied as stated in AASHTO LTS-4.
- B. Support-Structure Seismic Strength: Poles or other support structures, brackets, arms, appurtenances, bases, anchorages, and foundations shall be designed to prevent separation of components or fracture of poles, luminaire supports, or pole foundations during a seismic event.
- C. Strength Analysis: For each pole, multiply the actual equivalent projected area of light fixtures and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- D. Mountings, Fasteners, and Appurtenances:

1. Corrosion resistant, compatible with support components, and which shall not cause galvanic action and contact points.
 - a. Steel Components: Hot-dip galvanized after fabrication, complying with ASTM A 123/A 123M.
 - b. Mounting Hardware Fasteners: Hot-dip galvanized, complying with ASTM A 153/A 153M, or minimum 18-8 grade stainless steel.
 2. Accommodate attachments and wiring of other systems, as applicable.
- E. Light Fixture Attachment Provisions: Comply with light fixture manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
- F. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; 1-multi-piece construction up to 40 feet in height with access handhole in pole wall.
1. Shape: Round, tapered, segmented with steps.
 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
 3. Pole Shaft: The shaft shall be round or 8, 12, or 16 sided and be high strength low alloy tapered tubular steel that is equal to current ASTM A595 or ASTM A570 standards, with hot-dip galvanized coating inside and out. No single pole sections shall exceed 41 feet in length. All connections of pole sections shall be by slip fitting the top section over the lower section by a length of 1.5 times the female inside diameter. The shaft shall be pre-assembled by the manufacturer to assure perfect alignment and proper slip distance. It will then be match marked with a permanent marking for correct field assembly. All shafts shall be color coded for the Contractor's convenience during assembly, and color codes shall be forwarded to the Contractor before shipment. No intermediate horizontal welds will be permitted. All sections shall be pre-tested at the factory before shipment to insure proper fit-up for the Contractor's convenience. Lifting rings shall be welded to each end of every pole section. Rings shall be designed to withstand applied loading of each pole section. The rings shall be used to lift the pole sections and in the assembly of the sections.
 4. Resistance to Corrosion: Steel components of the pole shall be hot-dip galvanized to current ASTM A123 standards. To avoid problems of galvanize adherence to differing steel alloys, all steel components used for the pole shall be of the same type steel. Each shaft assembly shall be completely coated both inside and out with a single dip. Double dipping will not be permitted in compliance with USGA (United States Galvanizing Association) recommended practices. All miscellaneous hardware shall be galvanized in accordance with ASTM A153 specifications. Top of pole shall be capped or sealed to prevent rainwater from entering the interior of the pole.
- G. Steel Mast Arms: Truss type, continuously welded to pole attachment plate. Material and finish same as pole.
- H. Brackets for Light Fixtures: Detachable, cantilever, without underbrace.
1. Adapter fitting welded to pole and bracket, then bolted together with galvanized-steel bolts.
 2. Cross Section: Tapered oval, with straight tubular end section to accommodate light fixture.

3. Match pole material and finish.
 - I. Handhole: Each pole shall have a 5" x 8" handhole with reinforcing frame designed to replace the removed section. A detachable cover shall also be provided with each handhole. Additional handholes shall be placed at the cage location to provide access for wiring.
 - J. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
 - K. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
 - L. Base: Base Plate or Pre-cast Base. Concrete base design and materials shall be the responsibility of the field lighting pole manufacturer supplier/installer. Pole base structural design shall be signed and stamped by a Professional Engineer licensed in the state where the project is located.
 1. Base Plate: Base plates shall conform to ASTM A36 Grade 42. It shall be designed to resist the shaft's maximum moment at its full yield stress. Plates shall be integrally welded to the tubes with a telescopic welded joint or a full penetration butt weld with backup bars. If a telescopic weld is utilized, both external and internal lap joints shall be welded completely. Plates shall be hot dipped galvanized (ASTM A123) and powder coated as required.
 - a. Anchor Bolts: Anchor bolts shall be A36 Mod 55 with a minimum yield of 55,000 or A193-B7 with a minimum yield of 105,000 psi. They shall be designed to support the shaft at its maximum moment and not exceed the yield of the bolt. The moment shall be applied across the base so as to produce the maximum force in the anchor bolts. Anchor bolts shall be galvanized approximately 18", threaded end only. A checking template shall be provided for the Contractors use. Each anchor bolt shall be supplied with one (1) leveling nut and one (1) hold down nut and two (2) flat washers with strength equivalent to or exceeding the proof load of the bolt.
 2. Direct buried steel poles are not allowed.
 - M. Foundations:
 1. Foundation Drawings: Project specific foundation drawings sealed by a Professional Engineer in the state where the project is located are required. The foundation drawings must list the moment, shear (horizontal) force, and axial (vertical) force at ground level for each pole.
 2. Foundations shall be pre-stressed concrete bases embedded in concrete backfill or an anchor bolt foundation designed such that the steel pole and any exposed steel portion of the foundation be located a minimum of 18 inches above final grade. The concrete for anchor bolt foundations shall be allowed to harden for a minimum of 28 days before the pole stress is applied.
 3. Extend cast-in-place bolted foundations 36 inches (914mm) above grade, minimum.
 - N. Loading: Vertical forces due to pole weight, luminaires, attachments, maintenance device, panelboards, (4) future luminaires per pole, and one (1) maintenance person shall be included in the maximum stress at the base. Wind pressures, adjusted for shape and height, are applied to the centroids of all projected areas. Eccentric moments due to deflection under maximum wind and

eccentric loads shall be considered. Sum of maximum stresses shall not exceed the guaranteed minimum yield strength of the material. Base and anchor bolts shall be designed to withstand the maximum combined stress at the base of the pole.

- O. Welding: Welding shall be of highest quality and performed by American Welding Society certified welders (AWS D1.1 - Latest Revision). Circumferential and 90 degree base welds shall have 100% penetration and be free of cracking and undercutting. Longitudinal welds shall be free of cracks and undercutting and shall be performed with automatic processes. Quality of welds shall be assured by visual inspection with questionable areas inspected by magnetic particle to AWS D1.1 - Latest Revision, Section 8.15. Longitudinal weld on female section of lap splice shall be 100% penetration with quality being assured by ultra-sonic inspection to AWS D1.1 - Latest Revision, Section 8.15, modified so acceptable inclusion size is compatible with design criteria.
- P. The pole shall be designed using drag and height coefficients as published in the latest edition of the Standard Specifications for Structural Supports for Highway Signs and Luminaires. A set of engineering calculations showing point of maximum stress, shear loads and base moments shall be provided for poles of different heights and loading conditions. These calculations shall also provide information on the wind pressure, area, centroid, coefficient of height, coefficient of drag and force at every 10' feet. The calculations shall bear the seal of a Professional Engineer licensed in the State where the project is located. The Professional Engineer shall be employed on a full time basis by the manufacturer and shall be experienced in pole designs of this nature. The pole shaft, base plate, and anchor bolts, when loaded with the fixture quantity specified and crossarm, shall be designed to withstand an isotach wind velocity of 80 mph with a 1.3 gust factor based on the fifty (50) Year Mean Recurrence Interval Isotach Chart.
- Q. Poles will be accepted only from manufacturers having products in place for ten (10) years and engaged in supplying products of this nature on a regular basis.

2.6 CROSSARM ASSEMBLY

- A. Construction Material: The crossarm assembly shall be hot dip galvanized after fabrication to ASTM A123 specifications. It shall be pre-wired to a UL listed or recognized quick connector. Each crossarm shall be labeled for easy installation. All wiring shall be completely enclosed within the crossarm assembly. The crossarms shall be manufactured of rectangular steel tubing (FTY-46 KSI, ASTM A500 GRADE B) material and have silicone gasketed end caps or be continuously welded to prevent water from penetrating inside of crossarm. The assembly shall be mounted to a vertical galvanized steel shaft. A 4"x 6" hand hole shall be provided to allow for access connection of the wiring harness. Structural mounting hardware shall be galvanized. A removable pole top cap shall be provided. All welds shall be fillet type. A strain relief support and ground lug shall be provided. For ease of maintenance, system must be capable of re-lamping from the front or rear of the assembly. There shall be no penetration on the top or sides of the crossarms.
- B. Wiring: All wiring shall be factory pre-wired and enclosed inside the crossarm. Conductors shall be minimum 12 gauge rated at 600V and have 90°C insulation. Termination of each crossarm shall be by wiring harness.
- C. Socket Housing Attachment: Socket housing attachment to the crossarm shall be by a minimum of two stainless steel bolts. To ensure structural strength, the luminaire manufacturer shall provide all mounting hardware.

- D. The fixture crossarm shall be warranted (Limited Warranty) for a period of Ten (10) years and warrants to the purchaser that all assembly(s) shall be free from defects in materials and workmanship from the date of shipment. A copy of the manufacturer's warranty shall be submitted to the owner.

2.7 WIRING HARNESS

- A. General Description: Factory manufactured wiring harnesses shall be provided. Each harness shall have top and bottom quick connect plugs and be labeled for connection at each crossarm and ballast enclosure. The harness shall be enclosed and protected along the entire length of the harness. The harness shall be matched to luminaire quantity, wattage and fixture mounting height.
- B. Construction: Each harness shall use fully color coded wire for luminaire polarization. All wires shall be minimum 12 gauge rated at 600V and have 90°C insulation. The harness shall be spiral wound and have a stainless steel wire mesh support grip at the top. A ground wire shall be included for continuous system grounding. Each harness shall be labeled for easy identification and 100% electrically tested at the factory before shipment.
- C. NRTL Listing: The entire system shall be NRTL listed as an entire system.
- D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

2.8 GROUNDING AND LIGHTNING PROTECTION:

- A. Provide stand-alone lightning protection system that complies with NFPA 780 for field lighting structures. Refer to Division 26 Lightning Protection specification for additional information.
 - 1. Provide lightning protection air terminal on top of structure that is bonded to pole and connected to a copper grounding electrode conductor.
 - 2. Provide bonding conductor from air terminal on top of structure to ground lug at base of structure.
 - 3. Provide (2) 3/4" diameter by 10 foot long ground rods at base of structure installed 10 feet apart.
 - 4. Provide bonding conductor from ground lug at base of structure and connect to ground rods.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify conditions of equipment and installation prior to beginning work.
- B. Verify that equipment is ready for connecting, wiring, and energizing.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Complete installations for design of lighting systems for the field shall comply with requirements of the local Building Code and NEC.
- C. Use web fabric slings (not chain or cable) to raise and set structural members. Protect equipment during installation to prevent corrosion.
- D. Align poles for optimum directional alignment of light fixtures and their mounting provisions on the pole. Install poles and other structural units level, plumb, and square.
- E. Install lamps in each light fixture.
- F. Fasten light fixture to indicated structural supports.
- G. Adjust light fixtures that require field adjustment or aiming.
- H. Baffles and Louvers for Spill Light Correction: Install on lighting fixtures with fasteners provided by the manufacturer. Install and adjust to correct out-of-limit spill-light and glare measurements.
- I. Install remote drivers, and other auxiliary devices as required by manufacturer.
 - 1. Install ballasts, drivers, and devices within maximum remote distances and with wiring sized per manufacturer's recommendations.
 - 2. Provide label on device indicating panelboard circuit number.
 - 3. Properly support remote lighting devices, including, but not limited to ballasts, power supplies, and drivers, per Code and manufacturer's recommendations.
 - 4. Install controls and remote driver or ballast housings in cabinets mounted to support structure at least 10 feet above grade.
 - 5. Provide cabinets and enclosures suitable for installation environment as required.
- J. For controllable light fixtures, provide both control and power wiring between light fixture and control device and between light fixtures. Quantity of low voltage and line voltage wiring and wire type shall be per manufacturer's recommendations. At a minimum, provide the following based on control type at either 120V or 277V, unless recommended otherwise by the manufacturer:
 - 1. 0-10V – two low voltage conductors and two line voltage conductors plus ground
 - 2. Proprietary digitally addressable – as required per the manufacturer
 - 3. DMX – two line voltage conductors plus ground and DMX cabling.

3.3 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole, unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting light fixture to grounding system.
- B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor and conductor protector.
 - 3. Ground metallic components of pole accessories and foundations.

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform tests, inspections, and analysis according to IESNA RP-6 and IESNA LM-5 where applicable.
- B. Tests and Inspections:
 - 1. After installing sports lighting system and after electrical circuits have been energized, perform proof-of-performance field measurements and analysis for compliance with requirements.
 - 2. Illumination Measurements: Upon substantial completion of the project and in the presence of the Contractor, Project Engineer, Owner's Representative, and Manufacturer's Representative, illumination measurements shall be taken and verified. The illumination measurements shall be conducted in accordance with IESNA RP-6-01, Appendix B.
 - a. Baseball Fields: Measure at least 25 points of the infield and 129 points of the outfield. Extend the grid 15 feet (5 m) outside the foul lines, extending to outfield boundary or fence.
 - b. Softball Fields: Measure at least 25 points of the infield and 98 points of the outfield. Extend the grid 15 feet (5 m) outside the foul lines, extending to outfield boundary.
 - 3. Make field measurements at established test points in areas of concern for spill light and glare.
 - 4. Where sports lighting system is providing normal and emergency egress lighting for spectator areas measurements shall be taken and verified. Illumination measurements shall be conducted once under normal power conditions with all sports light fixtures on and again with only emergency sports light fixtures on. Measurements shall be conducted at the following locations:
 - a. Seating areas: Measure points in all seating areas illuminated by the sports lighting fixtures on a 20 foot by 20 foot grid. Measurements shall be taken at 36" above finished

floor.

- b. Walkways and concourse areas: Measure points in all walkways and concourse areas illuminated solely by the sports lighting fixtures on a 20 foot by 20 foot grid. Measurements shall be taken at the surface of the walking surface.
- 5. Perform analysis to demonstrate correlation of field measurements with specified illumination quality and quantity values and corresponding computer-generated values that were submitted with engineered design documents. Submit a report of the analysis. For computer-generated values, use manufacturer's lamp lumens that are adjusted to lamp age at time of field testing.
- C. Prior to installation of the support structures, inspect each installed fixture for damage. Replace damaged fixtures and components.
- D. Adjust all light fixture sockets to match the lamp specified and aim all adjustable light fixtures as directed by the Architect.
- E. Upon completion of the installation of light fixtures, and after building circuits have been energized, apply electrical energy to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- F. Clean light fixtures of dirt and debris upon completion of the installation. Protect installed light fixtures from damage during the remainder of the construction period.
- G. At the time of Substantial Completion, aim all adjustable fixtures, such as flood and spot lights, per the Architect's direction. Provide all necessary equipment to support this effort, such as scaffolds and lifts, as required.
- H. At the time of Final Acceptance of this Project by the Owner, all lamps shall be in working order and all light fixtures shall be fully lamped.
- I. Illumination Observations: Verify normal operation of lighting units after installing light fixtures and energizing circuits with normal power source.
- J. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards.
 - 2. Comply with the following IESNA testing guide(s): IESNA LM-5, "Photometric Measurements of Area and Sports Lighting."
- K. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
- L. Sports lighting will be considered defective if it does not pass tests and inspections.
- M. Correction of Illumination Deficiencies: Make corrections to illumination quality or quantity, measured in field quality-control tests, that varies from specified illumination criteria by plus or minus 10 percent. If, in the opinion of the Owner or his appointed Representative, the actual performance

levels including footcandles, uniformity ratios, and peak-demand kilowatt consumptions are not in conformance with the requirements of the performance specifications and submitted information, the Manufacturer and/or Contractor shall be liable to any or all of the following:

1. Add or replace luminaires, change mounting height, revise aiming, or install louvers, shields, or baffles.
 2. If luminaires are added or mounting height is changed, revise aiming and recalculate and modify or replace support structures if indicated. The Manufacturer or Contractor shall also replace poles to meet the new wind load (EPA) requirements or verify certification by a licensed Structural Engineer that the poles will withstand the additional wind load. Luminaire mounting heights shall not be adjusted without Engineer's approval.
 3. Do not replace luminaires with units of higher or lower wattage without Engineer's approval.
 4. Retest as specified above after repairs, adjustments, or replacements are made.
 5. Report results in writing.
 6. Contractor and/or manufacturer shall pay for additional trips made by Contractor, Project Engineer, Owner's Representative, and Manufacturer's Representative at no cost to the owner to re-measure illumination test after corrective measures have been performed.
- N. Correction of Excessive Illumination in Spill-Light-Critical Areas: If measurements indicate that specified limits for spill light are exceeded, at the expense of the manufacturer and/or Contractor, make corrections to illumination quantity, measured in field quality-control tests, that reduce levels to within specified maximum values.
1. Add or replace luminaires, change mounting height, revise aiming, or install louvers, shields, or baffles.
 2. If luminaires are added or mounting height is changed, revise aiming and recalculate and modify or replace support structures if indicated. The Manufacturer or Contractor shall also replace poles to meet the new wind load (EPA) requirements or verify certification by a licensed Structural Engineer that the poles will withstand the additional wind load. Luminaire mounting heights shall not be adjusted without Engineer's approval.
 3. Do not replace luminaires with units of higher or lower wattage without Engineer's approval.
 4. Retest as specified above after repairs, adjustments, or replacements are made.
 5. Report results in writing.
 6. Contractor and/or manufacturer shall pay for additional trips made by Contractor, Project Engineer, Owner's Representative, and Manufacturer's Representative at no cost to the owner to re-measure illumination test after corrective measures have been performed.

3.5 ADJUSTING

- A. Two (2) site visits, one for initial adjusting during construction and installation of light fixtures and one for final adjustment and aiming of light fixtures after substantial completion, will be provided by the manufacturer.
- B. Manufacturer shall adjust and aim all adjustable light fixtures as required to achieve the submitted and specified lighting levels. Contractor shall make provisions for supplying all scaffolds, lifts, and other tools and equipment as required.
- C. Where required, adjusting shall be done during hours of darkness. Upon notification by Contractor that all fixtures are correct as per shop drawings and functioning, that specified lamps have been verified, lighting designer or Architect shall coordinate with Contractor as to a mutually agreed upon time to complete adjusting. Failure of Contractor to notify Architect during substantial completion will result in failure to comply with specifications.

3.6 DEMONSTRATION

- A. Manufacturer's authorized representative will be responsible to train Owner's maintenance personnel to adjust, operate, and maintain light fixtures. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 270010 - GENERAL COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and to all following sections within Division 27.

1.2 SECTION INCLUDES

- A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.
- B. Division 27 of these Specifications, and Drawings numbered with prefix TN, generally describe these systems, but the scope of the Communications Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical and Telecommunications Drawings and Specifications; and Addenda.
- C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of Work, indicating the intended general arrangement of the equipment, fixtures, outlets and cabling without showing all of the exact details as to elevations, offsets, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.3 ABBREVIATIONS AND ACRONYMS

- A. ADA Americans with Disabilities Act
- B. AFF Above Finished Floor
- C. AHJ Authority Having Jurisdiction
- D. ANSI American National Standards Institute
- E. ASTM American Society for Testing and Materials

F.	BICS	Building Industry Consulting Service International
G.	ETL	Electrical Testing Laboratories, Inc.
H.	FCC	Federal Communications Commission
I.	FM	Factory Mutual
J.	GE	Grounding Equalizer
K.	IEEE	Institute of Electrical and Electronic Engineers
L.	LED	Light Emitting Diode
M.	NEC	National Electric Code
N.	NESC	National Electrical Safety Code
O.	NEMA	National Electrical Manufacturers Association
P.	NFPA	National Fire Protection Association
Q.	NRTL	Nationally Recognized Testing Laboratory
R.	OEM	Original Equipment Manufacturer
S.	OFCI	Owner Furnished Contractor Installed
T.	OSHA	Occupational Safety and Health Administration
U.	OSP	Outside Plant
V.	RCDD	Registered Communications Distribution Designer
W.	TBB	Telecommunications Bonding Backbone
X.	TGB	Telecommunications Grounding Bus-bar
Y.	TIA	Telecommunications Industries Association
Z.	TMGB	Telecommunications Main Grounding Bus-bar
AA.	UL	Underwriters Laboratories
BB.	UON or UNO	Unless Otherwise Noted

1.4 DEFINITIONS

- A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:

1. AHJ - The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
2. Approved Equivalents or Equal - For specific products, materials, equipment, or systems for which this Division specifically identifies the Contractor shall use as the basis for their bid. Where the term approved equivalent or equal is listed the contractor may submit documentation for review by the Design Consultant for approval. The Design Consultant's acceptance or rejection is final.
3. As Directed - means as directed by the Contract Administrator, or his representative.
4. Communications Room - means the location of a floor-serving facility for housing telecommunication equipment, cable terminations, and cross-connect wiring, as well as those for audio video systems and potentially other low-voltage systems such as security and fire alarm (electronic safety and security). This room is recognized in ANSI/TIA-569 as the transition point between the telecommunications horizontal (station) pathway facilities and the backbone (riser) pathway facilities.
5. Concealed - means embedded in masonry or other construction, installed behind wall furring or within drywall partitions, or installed within hung ceilings.
6. Conditionally Approved – the manufacturer has been found reputable by the design professional, but the design professional has not verified that the product offering by manufacturer meets to all specification requirements. Contractor shall adhere to submittal review process for final approval on products.
7. Contract Administrator: Where referenced in this Division, "Contract Administrator" is the primary liaison between the Owner and the Contractor. Specifically, for this project this is "the Owner's Representative".
8. Design Consultant - Where referenced in this Division, "Design Consultant" is the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Contract Administrator, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Design Professional, in addition to involvement by, and obligations to, the "Contract Administrator".
9. Furnish - "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."
10. Furnished by Owner (or Owner-Furnished) or Furnished by Others: "An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division.
11. Install - "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."
12. NRTL - Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction

(AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTL's that are acceptable to the AHJ, and standards that meet the specified criteria.

13. Provide - "To furnish and install complete, and ready for the intended use."
 14. Submit - means submit to Contract Administrator for review.
 15. Substitution - means a product meeting all requirements and specifications and having been approved by the Design Consultant to replace another product specifically identified herein.
 16. Wet Location - means a pathway that does not protect cables from moisture levels that are beyond the intended operating range of "inside" premises cable.
 - a. For example: Slab-on-grade construction where pathways are installed underground or in concrete slabs that are in direct contact with soil (e.g., sand and gravel) is considered a "wet location."
 - b. Also refer to the:
 - 1) Telecommunications Distribution Methods Manual (TDMM) for definitions of Wet locations
 17. (*) – Where appearing in product part or model numbers; shall represent wild card character to be filled in by the contractor to meet required specifications.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Design Consultant as equivalent to the item or manufacturer specified".
- C. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

1.5 REFERENCE STANDARDS

- A. Execute all Work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of Work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Contract Administrator's and Design Consultant's attention in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.
- B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator

and Design Consultant, without additional compensation. Contractor will be held responsible for any violation of the law.

- C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.
- D. All material, manufacturing methods, handling, dimensions, methods of installation and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them.
- E. The references to the following codes, references and standards represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the latest revision or printing (UON):
 - 1. ANSI/TIA-569 – “Commercial Building Standard for Telecommunications Pathways and Spaces”
 - 2. NFPA 70 – National Electrical Code (NEC)
 - 3. IEEE National Electrical Safety Code (NESC)
 - 4. Americans with Disabilities Act (ADA) of 1990, as amended

1.6 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with other Divisions for Communications work to be included but not listed in Division 27 or indicated on Communications Drawings.
- B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any Work covered by this Division.
- C. Refer to Communications Drawings and Divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Follow these drawings as closely as the actual construction and the work of other trades will permit. Provide all offsets, fittings, and accessories, required to clear equipment, beams and other structural members which may be required but not shown on the Drawings.
- D. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes actually installed.
- E. Maintain a project manager, as specified by the Quality Assurance sections of these specifications, on the jobsite at all times to coordinate this Work with other trades so that various components of the Communications systems are installed at the proper time, fits the available space, allows proper service access to all equipment, and meets all required codes and standards.
- F. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.

- G. Work of this Division shall progress according to the "Construction Schedule" as described in Division 01 and as approved by the Contract Administrator. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.
- H. Carefully check space requirements with other trades to ensure that equipment can be installed in the spaces allotted.
- I. Refer to Coordination requirements in specific sections for additional information.
- J. Examine and compare the Contract Drawings and Specifications with the Drawings and specifications of other trades, and report any discrepancies between them to the Contract Administrator and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before installation, make proper provisions to avoid interferences.
- K. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the Drawings as to the area to which it applies. Submit these drawings to the Contract Administrator for review. At completion include a set of these drawings with each set of Record Drawings.
- L. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions, which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections shall be made or which shall be changed or altered.
- M. In cases of doubt as to the work intended, or in the event of need for explanation, request supplementary instructions from the Contract Administrator.

1.7 MEASUREMENTS AND LAYOUTS

- A. The Drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional cost to the Owner, errors that could have been avoided by proper checking and inspection.

1.8 SUBMITTALS

- A. Refer to Division 1 and General Conditions for general submittal requirements. Refer to individual Division 27 Sections for additional submittal requirements. Unless otherwise noted, it is recommended to submit electronically in PDF format.
- B. Submittals and shop drawings shall not contain Henderson Engineers' firm name or logo, nor shall it contain the Engineer of Record's seal and signature. They shall not be photocopies or reproductions of Henderson Engineers' work product. If the contractor desires to use elements of such product, the license agreement for transfer of information at the end of this section shall be used.
- C. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

D. Unless noted otherwise within each individual section, submittals shall be provided for approval in four distinct phases:

1. Pre-bid

a. Required no less than two weeks prior to the due date for the submission of bids, such as:

- 1) Product substitutions, approved alternate or equivalent requests to be reviewed for approval (Prior to Bid)
- 2) Alternate personnel credentials to be reviewed for approval
- 3) And as required by individual sections in this Division

2. Bid

a. Required at the time of the submission of bids, such as:

- 1) Bid Response Forms
- 2) Unit Pricing (if required by sections in this Division)
- 3) Personnel Qualifications
- 4) Contractor Qualifications (Previous project references)
- 5) Voluntary Bid Alternates
- 6) And as required by individual sections in this Division

3. Pre-construction

a. Required after the award of the project to the winning bidder and prior to starting construction.

b. Submit the following items no longer than four weeks after receiving the notice to proceed:

- 1) Division of Labor amongst sub-contractors. Include:
 - a) Company Name
 - b) Address
 - c) Name of project manager for this project, including:
 - i) E-mail
 - ii) Telephone number
- 2) Construction schedule showing important milestone dates and activities. Schedule shall be coordinated with overall project construction schedule.

- 3) Updated Personnel and Contractor Qualifications where different from those submitted during the Bid phase.
- 4) A typed list, indexed by Specification section, of products specifically identified by part number (no wild card characters) within each specification section in this Division. Products are to be listed in the same order as in the specification. List is to include length of manufacturer warranty for each product.
- 5) Manufacturers' cut-sheets:
 - a) Cut-sheets are to be in the same order as in the specification sections.
 - b) At a minimum all cut-sheets shall contain the following:
 - i) Cross-reference to the specification section and/or drawings for which the product is to be reviewed for compliance and acceptance
 - ii) Every product cut-sheet submitted for review shall contain the manufacturers' name and logo somewhere on the page
 - iii) All parts, pieces, and equipment submitted for review shall be clearly identified by stamp, markup, or highlight in such a manner that the product(s) being submitted are clearly identifiable and distinguished from all other materials, parts, or equipment that may be on the submittal.
 - iv) For cut-sheets with accessories, additional parts, or derivations of the product being submitted, all shall be clearly identified for the reviewer and acceptance.
 - v) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL listings, approval or certification information, and other necessary identifying information to confirm product meets specifications.
- 6) Samples – refer to individual sections for specific sample requirements.
 - a) Samples requested shall be physical examples that represent materials, equipment or workmanship and establish standards by which the work will be judged. Contractor or Manufacturer shall cover all associated fabrication and shipping costs.
- c. Submit the following items sufficiently prior to installation of each respective portion of work:
 - 1) Shop Drawings
 - a) Shall be furnished per the requirements of each Division 27 specification Section.

4. Project Completion

- a. Required after the substantial completion but prior to final approval for completion, such as:
 - 1) Record Drawings
 - 2) Operation and Maintenance Data
 - 3) Project test reports
 - 4) Cable Databases (as applicable)
 - 5) Warranty Certificate(s)
 - 6) Lead Installer / Project manager letter with signature stating the project has been installed in accordance with referenced industry standards and contract documents.
 - 7) And as required by individual sections in this Division
- E. Refer to Division 01 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Design Consultant that the shop drawings have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name, and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator and Design Consultant's designated representatives. Contractor shall allow the Design Consultant review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the electronic submittal and shall clearly indicate the materials, performance criteria and accessories being proposed. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- F. Identify each sheet of printed submittal pages (using arrows, underlining or circling) to show applicable sizes, types, model numbers, ratings, capacities and options actually being proposed. Cross out non-applicable information. Note specified features such as materials or paint finish.
- G. Provide submittals in sufficient detail to demonstrate compliance with these Contract Documents and the design concept.
- H. Transmit submittals as early as required to support the project schedule. Allow for two weeks Design Consultant review time, plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittals, if required. Transmit submittals as soon as possible after Notice to Proceed and before construction starts.
- I. No part of the work shall be started in the shop or in the field until the shop drawings and samples for that portion of the work have been submitted and accepted.
- J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and allow ample room for maintenance. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- K. The Contractor is not relieved of the responsibility for dimensions or errors that may be contained on submissions, or for deviations from the requirements of the Contract Documents. The noting of some

errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the shop drawings, product data and samples, the Contract Documents govern the work and are neither waived nor superseded in any way by the review of shop drawings, product data and samples.

- L. Submittals shall contain the following information. Submittals not so identified will be returned to the Contractor without action:
 - 1. The project name
 - 2. The applicable Specification Section and paragraph
 - 3. The submittal date
 - 4. The submitting (sub-)contractor's company name and the project manager's name and contact information.
- M. Include dimensional data for roughing in and installation and technical data sufficient to verify that equipment meets the requirements of the Contract Documents. Include wiring, piping and service connection data.
- N. The Design Consultant's checking and subsequent acceptance of such submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless he has, in writing, called the Design Consultant's and Contract Administrator's attention to such deviations at the time of submission, and secured written acceptance; nor shall it relieve the Contractor from responsibility for errors in dimensions, details, sizes of members, or quantities; or for omissions of components or fittings; or for not coordinating items with actual building conditions and adjacent work.
- O. The work described in shop drawing submissions shall be carefully checked by all trades for clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and coordination with other trades on the job. Each submitted shop drawing shall include a certification that related job conditions have been checked by the Contractor and each Subcontractor and that conflicts do not exist.
- P. Maintain a complete set of reviewed and stamped shop drawings and product data on site.
- Q. Inadequate or incomplete shop drawings, product data and/or samples will not be reviewed and will be returned to the Contractor for resubmittal.

1.9 SUBSTITUTIONS

- A. Refer to Division 1 and General Conditions for substitutions in addition to requirements specified herein.
- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
2. The burden of proof of the merit of the proposed substitution is upon the proposer.
3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Contract Administrator, and Owner the following:
 - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
 - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
 - c. Proposed substitution has received necessary approvals of the Authorities Having Jurisdiction.
 - d. Same warranty will be furnished for proposed substitution as for specified Work.
 - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
 - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
2. No substitutions will be considered prior to receipt of bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of bids.
3. If the proposed substitution is approved prior to receipt of bids, such approval will be stated in an addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.10 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet.
- B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.

- C. Contact the Contract Administrator for written authorization.
- D. The following must be received before electronic drawing files will be sent:
 - 1. Contract Administrator's written authorization
 - 2. Engineer's release agreement form
 - 3. Payment

1.11 QUALITY ASSURANCE

- A. Execute all work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the work specified.
- B. Install all work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.
- C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

1.12 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish to the Contract Administrator, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- E. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees.

- F. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Contract Administrator and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives.

1.13 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections of this Division.

1.14 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.
- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Contract Administrator.

1.15 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Contract Administrator.
- D. Be responsible for the safe storage of tools, material and equipment.

1.16 WARRANTIES

- A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified herein.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- C. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in these Construction Documents or manufacturer's standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 01.
- D. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.
- E. Perform the remedial work promptly, upon written notice from the Contract Administrator or Owner.
- F. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.17 TEMPORARY FACILITIES

- A. Refer to Division 1 and General Conditions for Temporary Facilities requirements.
- B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 PERMITS AND FEES

- A. Secure and Pay all required fees and obtain all required permits related to the Communications Infrastructure installation.

- B. Pay royalties or fees in connection with the use of patented devices and systems.

3.3 ACCESS TO EQUIPMENT

- A. Locate all pull boxes, junction boxes and controls so as to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to Division 26 Section "Common Work Results for Electrical".
- B. Maintain all code required clearances and clearances required by manufacturers.

3.4 PENETRATIONS

- A. Unless otherwise noted as being provided under other divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions and ceilings for all electrical work that passes through construction. Refer to Division 27 Section "Common Work Results for Communications".
- B. Provide sleeves, box frames, or both, for all conduit, cable, and cable trays that pass through masonry, concrete or block walls.
- C. The cutting of new and/or existing construction will not be permitted except by written approval of the Contract Administrator.

3.5 EXCAVATION AND BACKFILLING

- A. Refer to Division 01, Division 02 and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.
- B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this division. Excavation shall be in conformance with applicable Divisions and sections of the Specifications.
- C. Restore roads, alleys, streets and sidewalks damaged during this work to the satisfaction of Authorities Having Jurisdiction.
- D. Do not excavate trenches close to walks or columns without prior consultation with the Contract Administrator.
- E. Erect barricades around excavations, for safety, and place an adequate number of amber lights on or near the work and keep those burning from dusk to dawn. Be responsible for all damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.
- F. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.
- G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.
- H. Install sediment and erosion control measures in accordance with local codes and ordinances.
- I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.
- J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
 1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
- K. Excavation for Underground Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
 1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of one inch in diameter and larger with emulsified asphalt tree paint.
 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- L. Trenching: Excavate trenches for electrical installations as follows:
 1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of six to nine inches clearance on both sides of raceway and cables.
 2. Excavate trenches to depth indicated or required for raceway and cables to establish slope, away from buildings and indicated elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
 3. Limit the length of open trench to that in which raceway and cables can be installed, tested, and the trench backfilled within the same day.
 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceway and cables. Provide a minimum of six inches of stone or gravel cushion between rock bearing surface and raceway and cables.

5. Excavate trenches for raceway, cables, and equipment with bottoms of trench to accurate elevations for support of raceway and cables on undisturbed soil.
- M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.
- N. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
 2. Under building slabs, use drainage fill materials.
 3. Under raceway and cables, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
 4. For raceway and cables less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation and testing of raceway and cables, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
 5. Other areas use excavated or borrowed materials.
- O. Backfill excavations as promptly as work permits, but not until completion of the following:
1. Inspection, testing, approval, and locations of underground utilities have been recorded.
 2. Removal of concrete formwork.
 3. Removal of shoring and bracing, and backfilling of voids.
 4. Removal of trash and debris.
- P. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
1. For vertical and diagonal raceway installations, thoroughly support raceways from permanent structures or undisturbed earth at no less than 10-foot intervals, while placing backfill materials, so that raceways are not deflected, crushed, broken, or otherwise damaged by the backfill placement.
- Q. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- R. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.

- S. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:
1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
 - a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
 2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.
- T. Subsidence: Where subsidence occurs at mechanical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.6 CUTTING AND PATCHING

- A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.
- B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.
- C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.
- D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.
- E. Patch around openings to match adjacent construction, including fire ratings, if applicable.
- F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

3.7 PAINTING

- A. Refer to Division 09 Section "Painting" for painting requirements.
- B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.
- C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
- D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
- E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

3.8 CLEANING

- A. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to final inspection, make a final cleanup of dirt and refuse resulting from Work and assist in making the premises vacuum clean. Clean all material and equipment installed under this Division.
- C. Remove dirt, dust, plaster, stains, and foreign matter from all surfaces.
- D. Touch up and restore damaged finishes to their original condition.
- E. All communications equipment shall be thoroughly vacuumed and wiped clean prior to startup and at the completion of the project. Equipment shall be opened for observation as required.

3.9 ADJUSTING, ALIGNING AND TESTING

- A. Adjust, align and test all equipment furnished and/or installed under this Division.
- B. Check and test protective devices for specified and required application, and adjust as required.
- C. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.
- D. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.
- E. Refer to individual Sections for additional and specific requirements.

3.10 START-UP OF SYSTEMS

- A. Prior to start-up of each system, check all components and devices to confirm compliance with manufacturers' recommended installation procedures.
- B. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.
- C. Refer to individual Sections for additional and specific requirements.

3.11 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:
 - 1. Submit results of systems tests and adjustments per each individual section.
 - 2. Submit complete Operation and Maintenance Data.
 - 3. Submit complete Record Drawings.
 - 4. Perform all required training of Owner's personnel.
 - 5. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
 - 6. Perform start-up tests of all systems.
 - 7. Remove all temporary facilities from the site.
 - 8. Comply with all requirements for Substantial Completion in the Division 1 and General Conditions.
- B. Request in writing a review for Substantial Completion and scheduling of final acceptance. Provide a minimum of five (5) business days notice prior to the review for project sites within a 4-hour drive from the office where the design was created; provide a minimum of eight (8) business days notice for sites beyond a 4-hour drive.
- C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Contract Administrator and Design Consultant for time and expenses incurred for the visit.
- F. Upon completion of the review, the Contract Administrator and Design Consultant will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

- G. Omissions on the “final list” shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

3.12 EARLY OCCUPANCY

- A. Failure to meet the Substantial Completion date can result in the Owner needing to take early occupancy. Complete the systems which are necessary to allow partial early occupancy of the building by original Substantial Completion date.
 - 1. Refer to individual sections for additional requirements.
- B. Verify and comply with requirements for temporary occupancy with the local Building and Fire Departments.

END OF SECTION 270010

SECTION 270500 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

- A. This Section includes general construction materials and methods, communications equipment coordination, and common communications installation requirements for Division 27 systems as follows:
 - 1. Grounding and Bonding for Communications
 - 2. Pathways for communications systems.
 - a. Cable Hook Systems
 - b. Conduit
 - c. Outlet Boxes
 - d. Floor Boxes
 - e. Pull Boxes
 - f. Cable Tray
 - 3. Firestopping Systems
 - 4. Access Panels
 - 5. Identification

1.2 RELATED REQUIREMENTS

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in the following Sections: 27 Section "General Communications Requirements"
- B. Division 07 Section "Penetration Firestopping" for fire stopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
- C. Division 26 for reference regarding materials and methods for additional requirements.
- D. Division 27 "General Communications Requirements"

1.3 DEFINITIONS

- A. AV – Audio Video
- B. Cable Tray System – A unit or assembly of units or sections and associated fittings forming a structural system used to securely fasten or support cables and raceways.
- C. Common Work – all Work specified in this section.
- D. Conduit Body – A separate portion of a conduit or tubing system that provides access through a removeable cover(s) to the interior of the system at a junction of two or more sections of the system or at a terminal point of the system. Boxes such as FS and FD or larger cast or sheet metal boxes are not classified as conduit bodies.
- E. Conveniently Accessible – Capable of being reached from the floor or via the use of an 8 foot step ladder without crawling or climbing over or under obstacles such as piping, duct work, motors, transformers, pumps, etc.
- F. EMT: Electrical Metallic Tubing
- G. Firestopping System – Firestopping products that have been specifically tested and rated by a Nationally Recognized Testing Laboratory (NRTL), such as UL, to provide the required flame (F), fire and temperature (T), air and smoke (L), and water (W) containment for a given partition/penetration.
- H. Floor Box Assembly (Floor Box) – An on-grade solution or above grade (with a native fire classification or in combination with an approved Firestopping System) solution for in-floor terminations. The Assembly consists of pour pan (as applicable), Firestopping System (as applicable), floor box (compartment), plate mounting brackets, line voltage divider plates, termination plates, termination connectors, electrical receptacle(s), gang plates (termination cover plates), and access door / cover / lid.
- I. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.
- J. IMC – Intermediate Metal Conduit
- K. Plenum – A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
- L. Plenum-rated – A product that is listed by a NRTL as being suitable for installation into a plenum space.
- M. Point of Entrance (Building Entrance) – The point within a building where the Outside Plant (OSP) communications cabling emerges from an external wall, a concrete floor slab, or IMC/RMC. If Communications Point of Entrance isn't identified on the drawings, assume the Main Communications (MDF) also acts as the Point of Entrance.
- N. Poke Through Assembly (Poke-Thru) – An above grade solution with a native fire classification for in-floor terminations. The Assembly consists of pre-pour sleeve (as applicable), Firestopping System, fire resistant conduit stub, poke thru (compartment), plate mounting brackets, line voltage divider plates, termination plates, termination connectors, electrical receptacle(s), gang plates (termination cover plates, as applicable), and access door / cover / lid.

- O. Quality Control Specialist – as it pertains to Work within this section, Quality Control Specialist is the Project RCDD, as defined in Division 27 Section “Structured Cabling System”, for Common Work for Telecommunications.
- P. RMC – Rigid Metal Conduit
- Q. UL – Underwriters Laboratory

1.4 REFERENCE STANDARDS

- A. Follow all applicable codes, references, guidelines, and standards listed in Division 27 Section “General Communications Requirements”.
- B. Follow the additional codes, references, standards and guidelines:
 - 1. NEMA VE 1-2017 – “Metallic Cable Tray Systems”
 - 2. NEMA VE 2-2013 with 2016 Corrections – “Cable Tray Installation Guidelines”
 - 3. ASTM E 814 and ANSI/UL1479 – “Fire Tests Through Penetration Firestops”
 - 4. ASTM E 84 and ANSI/UL 723 “Surface Burning Characteristics of Building Materials”
 - 5. ASTM E 119 and ANSI/UL 263 “Fire Tests of Building Construction Materials”

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication:
 - 1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
 - 2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.
 - 3. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed.

1.6 SUBMITTALS

- A. Follow the requirements for submittals in Division 27 Section “General Communications Requirements”.
- B. ”Bid” Phase
 - 1. Contractor Qualifications for Firestopping Systems: Provide copies of training/certification as required in the Quality Assurance portion of this specification section.
- C. “Pre-construction” Phase
 - 1. Manufacturers’ cut sheets or catalog cut sheets of each of the pathways not specifically identified by its exact part number:
 - a. In addition to Division 27 Section “General Communications Requirements”, include the following:
 - 1) Size – including physical and loading dimensions
 - 2) Maximum span length
 - 3) Weight supported
 - 4) Type
 - 5) Fittings to be used
 - 6) Method of attachment to structure
 - 7) Firestop system assembly information for each system to be installed:
 - a) Documentation from UL catalog for each system proposed. This documentation shall include the following information:
 - i) Firestop manufacturer
 - ii) UL system number
 - iii) F, T, and L Ratings
 - iv) The complete description of the firestop system; To include what specific construction the system is intended to pass through such as a wall or floor assembly, the penetrating items allowed to pass through the opening in the wall or floor assembly, and the materials designed to prevent the spread of fire through the openings.
 - 8) As well as any additional information required by individual sections of this Division
 - 2. Shop Drawings
 - a. Submit for review scaled layout drawings showing the size/routing of all pathways and the size/information/locations of all boxes, pullboxes, firestopping systems, and access panels.

- 1) Each pathway shall be identified by type and size on the drawings.
 - a) Example #1: 4" EMT
 - b) Example #2: 4" x 12" Cable Tray
 - 2) Each grounding conductor shall be identified by size (and insulation):
 - a) Example: #3/0 insulated ground
 - 3) Each firestop system shall be identified by Manufacturer and Product, as well as UL system number for that particular location.
 - a) Example #1 – Firestopping Sleeve:
EZ-Path Series 22, UL System W-L-3255
 - b) Example #2 – Backbox in Fire-Rated Wall:
Specseal Power Shield, UL System QCSN/CLIV.R14288
 - 4) Each pullbox and access panel shall be identified by size and height above finished floor.
 - a) Pullbox Example: Pullbox 8" x 24" x 40" approximately 12' AFF.
- b. Unless otherwise required by these specifications, it is permissible to show pathways systems (conduit, cable tray, auxiliary supports, etc.) on the same shop drawing along with the cabling and system work to be installed through those pathways.
- 1) Division 271000 "Structured Cabling System" and their individual pathways shall be separate shop drawings; shared pathways such as cable tray shall be shown on both shop drawings.

D. Project Completion

1. Record Drawings:

- a. The Quality Control Specialist shall review the installation and Record Drawings for the Common Work Results required for their scope of work and shall stamp the final Record Drawings with their RCDD or CTS-I stamp before submission. By stamping the Record Drawings, the Quality Control Specialist indicates that the Common Work Results have been installed per the Contract Documents and all associated codes, standards, and guidelines, and all changes to the drawings have been incorporated into the Record Drawings.

1.7 QUALITY ASSURANCE

- A. Submittals and Shop Drawings for all Common Work Results specified in this section shall, if not created by, be reviewed by the Quality Control Specialist.

1. The Quality Control Specialist shall stamp all relevant submittals for their associated Division 27 sections, which indicates that at a minimum the proposed work has been reviewed by them and found to be in compliance in regards to:
 - a. All applicable codes and industry standards and guidelines referenced in Division 27.
 - b. Being fully-coordinated with all other trades and to be installed per the Construction Documents.
 - c. And installed per manufacturer's direction.
- B. The Quality Control Specialist shall also make weekly inspections during construction to ensure all work installed per this section is correct.
 1. Any deficiencies encountered prior to and during installation shall be corrected by the installing contractor under the direction of the Quality Control Specialist and/or the Design Consultant.
- C. Firestopping Systems
 1. Firestopping material and systems shall be tested and listed by UL. All firestopping products shall bear this classification marking.
 2. Installation technicians shall be by qualified and trained personnel. Acceptable installer qualifications are as follows:
 - a. FM Research, approved in accordance with FM AS 4991.
 - b. Individuals who are trained and certified by the firestopping manufacturer. For Specified Technologies, all installers shall have current FIT Level 1 certification.

1.8 NOISE CRITICAL SPACES

- A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The list below designates the noise-critical spaces that will require application of sound attenuating measures and acoustical sealants or sleeves.
 1. Offices
 2. Conference Rooms
 3. Music Teaching Rooms

PART 2 - PARTS AND MATERIALS

2.1 GROUNDING AND BONDING FOR COMMUNICATIONS

- A. Refer to drawings and Division 27 Section "Telecommunications Equipment Room Fittings" for exact grounding and bonding requirements.

2.2 PATHWAYS FOR COMMUNICATIONS SYSTEMS

A. General

1. All non-continuous cable supports shall be designed to prevent degradation of cable performance and pinch points that could damage cable
2. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
3. Telecommunications pathways shall be routed back to serving Communications Room. Refer to Drawings for additional information.

B. Cable Hook Systems (“J-hooks”)

1. The following manufacturers are Conditionally Approved.
 - a. Cooper/B-Line
 - b. Erico/Caddy
 - c. Monosystems
 - d. Panduit
 - e. Snake Tray
 - f. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)
2. Specifications
 - a. Have a flat bottom and sufficient width to comply with the minimum bend radius of all cabling as required by the referenced standards and manufacturers recommendations
 - b. Be open for easy lay-in and removal of cabling
 - c. Be designed so the mounting hardware is recessed to prevent cable damage
 - d. Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3
 - e. Cable hooks for corrosive areas shall be stainless steel, AISI Type 304
 - f. Be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions
 - g. Be factory assembled multi-tiered cable hooks shall be used where required to provide separate cabling compartments, or where additional capacity is needed
3. Cable hooks for installation above ceilings shall be
 - a. B-Line series BCH21, BCH32, BCH64

- b. Caddy CABLE-CAT 21 or 32 series hangers
- c. Or equivalent from Conditionally Approved manufacturer

C. Conduit

1. Specifications

- a. Refer to Electrical Division 26 for specific product and material information.
 - 1) Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.
- b. Conduits provided as connection to incoming services, utilities, including private services to other buildings or outside connection points shall be rigid metal or intermediate metal conduit at the point it enters the building, emerges from an exterior wall or ground floor slab to the final termination/transition point.
- c. If services enter a room or space such as a mechanical room, electrical room or other intermediate room due to convenience or proximity to the exterior and adequate space has not been provided within 50 feet (15.3 m) for the equipment needed for transitioning these and future cables/services to an appropriately rated indoor cable then those conduits shall be continued uninterrupted (except for necessary pull boxes) to the final connection point or location where the transition point has been designated. Generally this connection point will be a designated Entrance Room for Communications or the Main Telecommunication space. If space has not been identified the contractor shall request information prior to bid.
- d. Follow Electrical Division 26 for conduits underground, in slab or anywhere not within the building.
- e. Provide conduit as indicated on the Drawings or required by this Specification. Minimum conduit size shall be 1 inch (25.4 mm) for structured cabling. Provide a polypropylene or monofilament plastic line with not less than 200-lb (90.7 kg) tensile strength in each empty conduit. Permanently mark or tag each conduit or pull box, identifying it as communications (Telecom), AV, TV, Broadcast, Intercom, etc.), at intervals of not more than 75 feet (22.9 m). Each conduit that is stubbed into the ceiling space from an outlet box shall be permanently marked or tagged; refer to Labeling requirements in Section 3 – Execution.
- f. Route an empty conduit from each outlet box into the ceiling space above and terminate with a nylon bushing. In rooms with a non-accessible ceiling, route conduits to the nearest accessible corridor ceiling or communications space.

<u>Number of Structured Cabling Outlets/Connectors</u>	<u>Conduit Size</u>
Up to 4	1 inch (25.4 mm)
Up to 9	1-1/4 inch (31.8 mm)

D. Acoustical Pathway

1. Specifications

- a. For use in non-rated walls only.
 - b. For use in place of conduit sleeves through walls of noise critical spaces.
 - c. Plenum Rated (to UL2043)
 - d. Sound Transmission Classification (STC) as tested per ASTM E90 shall be greater than 60.
 2. Manufacturer shall be:
 - a. Hilti CS-SL SA
 - b. Specified Technologies, Inc. - NEZ33
- E. Outlet Boxes
1. Specifications
 - a. Boxes shall either be square or rectangular, as noted on the drawings. Dimensions indicate minimum size.
 - b. Telecommunications – for outlets shown on TN series drawings:
 - 1) For stud walls: dual-gang outlet box shall be a minimum size of 4-11/16 inches (119.1 mm) width by 4-11/16 inches (119.1 mm) height by 2-1/8 inches (54 mm) depth, with a dual-gang or single-gang raised cover/extension ring (as indicated on the drawings) a minimum of 3/8" deep. Depth shall match that of wall gypsum board(s).
 - a) Double gang – RACO 258/259 (Coordinate knock-out size with conduit size indicated on drawings); or
 - b) RANDL T-55017; or
 - c) Or equivalent from
 - i) Emerson/Appleton
 - ii) Thomas & Betts/Steel City
 - iii) Approved Substitution
 - 2) For ceilings (flush or above accessible ceiling): plenum-rated, dual-gang outlet box shall be a minimum size of 4 inches (101.6 mm) width by 4 inches (101.6 mm) height by 2-1/8 inches (54 mm) depth, with a dual-gang or single-gang raised cover/extension ring (as indicated on the drawings) a minimum of 3/8" deep. Depth shall match thickness of gypsum ceiling board(s) or accessible ceiling panel (if applicable).
 - a) Double gang – RACO 239 or equivalent, with ceiling grid framing where installed in accessible ceiling.

- b) Or equivalent from
 - i) Emerson/Appleton
 - ii) Thomas & Betts/Steel City
 - iii) Approved Substitution
- 3) For 6" or 8" deep masonry walls: where single-gang faceplates are shown on the drawings, provide single-gang backbox a minimum of 3-1/2 inches deep; where double-gang faceplates are shown on the drawings, provide double-gang backbox a minimum of 3-1/2 inches deep.
 - a) Single gang – RACO 695
 - b) Double gang – RACO 696
- 4) Weatherproof: Aluminum die cast, weatherproof box with 1" conduit connection. Where single-gang faceplates are shown on the drawings, provide single-gang backbox a minimum of 2-1/2 inches deep; where double-gang faceplates are shown on the drawings, provide double-gang backbox a minimum of 2-1/2 inches deep.
 - a) Single gang – Thomas and Betts – IHD3-3 or equivalent
 - i) Or equivalent from
 - (1) Emerson/Appleton
 - (2) Hubbell/RACO
 - (3) Approved Substitution
 - b) Double gang – Thomas and Betts – 2IHD5-3 or equivalent
 - i) Or equivalent from
 - (1) Emerson/Appleton
 - (2) Hubbell/RACO
 - (3) Approved Substitution

F. Floor Boxes

1. General

- a. Basis-of-Design Product: See Division 26 Specifications for product information.
- b. Floor Box Schedule on drawings: Where titles in this section are column or row headings that introduce lists, the requirements listed for that title apply to product selection.
- c. Provide a complete Floor Box Assembly.

- d. UL514A listed for scrub water exclusion for all floor types.
- e. The following items are not provided per this specification section:
 - 1) Electrical receptacle(s) shall be provided per Division 26 Section “Wiring Devices” or as indicated on the Drawings. Refer to Electrical Drawings and Division 26 Specifications for receptacle types, quantities and colors. Unless otherwise noted, all floor boxes shall contain electrical power receptacles. If no requirements are listed elsewhere, provide a minimum of one normal 20A, 125V NEMA 5-20R duplex receptacle.
 - 2) Include provisions for mounting communications faceplate and connectors in accordance with the requirements of the communications systems provider. Telecommunications outlet termination plate and termination connectors shall be provided per Division 27 Section “Communications Horizontal Cabling”. Coordinate all other Assembly components to ensure compatibility.
2. **Box Type E - Multi-Service (2 compartment):** For slab on grade: watertight, Class 1, fully adjustable, cast iron. For slab above grade: concrete-tight, Class 2, fully adjustable, stamped galvanized steel. Two compartments - one side plate with knockouts for communications faceplate and connectors; one side plate with provisions for one duplex receptacle. Furnish polycarbonate or nylon cover and flange piece with standard color as directed by Architect. Conduits shown on plans are minimum size; select appropriate floorbox based on slab type, thickness, and minimum conduit size. Shallow above-grade slabs necessitate use of Poke-Through Outlet.

<u>MFR</u>	<u>CAST IRON</u> <u>BOX</u>	<u>STAMPED</u> <u>STEEL BOX</u>	<u>RECEP</u> <u>TACLE</u> <u>PLATE</u>	<u>BLANK PLATE</u>	<u>COVER</u>
Steel City	664-CI (accepts (3) 1" conduits in Communication s compartment)	664	664-RP, 664-GP (Decorat or Style)	664-BP	664-CST Series
Wiremold	RFB2-OG	RFB2-SS	RFB2DP , RFB2B (Decorat or Style)	RFB2B	FP Series
Hubbell	3SFBC (accepts (1) 1-1/4" conduit in Communication s compartment)	3SFBSS (accepts (1) 1" conduit in Communicatio ns compartment)	3SFBRP , 3SFBDS (Decorat or Style)	3SFBB	3SFBCxxA Series

3. **Box Type F - AV / Multi-Service (3 or 4 compartment):**
 - a. Refer to Audio Video drawings and specifications for exact floorbox requirements. If there are no AV drawings and specifications, then the following requirements apply:

- 1) For slab on grade: watertight, Class 1, fully adjustable, cast iron, unless otherwise noted. For slab above grade: concrete-tight, Class 2, fully adjustable, stamped galvanized steel.
- 2) Three to four compartments, 3-1/2-inch maximum overall depth, and provisions for power receptacles and communications faceplate and connectors. Furnish hinged cover and nylon or polycarbonate flanged trim with standard color as directed by Architect.
- 3) Conduits shown on plans are minimum size; select appropriate floorbox based on slab type, thickness, and minimum conduit size.

<u>MFR</u>	<u>SLAB-ON-GRADE</u> <u>BOX</u>	<u>STAMPED</u> <u>STEEL BOX</u>	<u>ELECTRICAL</u> <u>RECEPTACLE</u> <u>PLATE</u>	<u>BLANK PLATE</u>	<u>COVER</u>
FSR	FL-500P-3" (accepts up to (4) 1-1/4" conduits) with Pour Pan (concrete-tight, acceptable only when used with Pour Pan)	FL-500P-3" (accepts up to (4) 1-1/4" conduits)	FL-P3"- DECORA	FL-P3"	FL-500P Series
Steel City	665-CI	665	665-RP, 665-GP (Decorator Style)	665-BP	665-CST Series
Wiremold	RFB4-CI	RFB4	RFB-DR, RFB- GFI (Decorator Style)	RFB-B	FP Series
Hubbell	HBLCFB401CB	HBLCFB301 BASE	HBLST302SGY, HBLDE301SGY (Decorator Style)	HBLBL300SGY	HBLTCGNT Series

G. Pull Boxes – for interior use only

1. Specifications
 - a. NEMA 1
 - b. Refer to Execution section for sizing requirements.
2. The following manufacturers are Conditionally Approved.
 - a. NEMA Enclosures
 - b. Wiegmann
 - c. Or Equivalent

H. Flexible cable tray

1. The following manufacturers are Conditionally Approved.
 - a. Atkore/Cope

- b. Bettermann Group/Chalfant
- c. Chatsworth
- d. Eaton/Cooper B-Line
- e. Hubbell
- f. Legrand/Cablofil
- g. MonoSystems
- h. MPHusky
- i. nVent/Hoffman
- j. Schneider Electric/WIBE
- k. Snake Tray
- l. Thomas & Betts
- m. WBT LLC
- n. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)

2. Specifications

- a. *Cable Tray Size: Size identified on drawings indicate minimum width and depth size. Provide cable tray of sufficient size to accommodate a maximum calculated fill ratio of 50% for all Division 27 and 28 cabling, to include all cables installed plus 25% growth.*
- b. Cable tray systems shall be pre-fabricated structures for supporting and routing cables or conductors that are pulled or laid in place after the pathway has been installed as a complete system
- c. Flexible cable tray systems shall consist of straight sections, fittings, and accessories as necessary for a complete, continuously grounded system.
 - 1) Cable tray and accessories shall be UL Classified as an equipment ground conductor.
- d. Wire basket shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.
- e. Cable Tray Materials: Steel rod and/or wire; corrosion resistant to the degree suitable for the environment where it is to be installed; field-bendable.
- f. Cable Tray Types:

- 1) Wire cable tray: a cable tray manufactured from metal wire welded at all intersections and is formed to provide a channel for the cables.

2.3 FIRESTOPPING SYSTEMS

A. General

1. All firestopping systems for Division 27 conduit, sleeves, cabling, boxes, etc. shall be from a single manufacturer, unless otherwise noted.
2. The following manufacturers are Conditionally Approved.
 - a. Hilti
 - b. Specified Technologies, Inc
3. Communications ladder rack and cable tray shall not continue through a fire-rated wall. Stop the tray, install multiple fire-rated pathway devices, and continue tray on the other side. Ensure grounding of the tray is continuous through the wall.

B. Fire-Rated Pathway Device – for sleeves through a single penetration (wall or floor)

1. Specifications
 - a. Minimum performance requirements: Shall meet testing requirements of ASTM E-814 or U.L. 1479; Shall be installed in accordance with the NRTL. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
 - b. Shall meet or exceed the ratings of the wall or floor that it penetrates.
 - c. Shall be a pre-fabricated and zero-maintenance solution which requires no action to activate the fire and smoke protective characteristics of the device.
 - d. Allows the installation and removal of cables without the need to remove or add any materials.
 - e. Used to seal penetrations of cables through fire rated partitions
 - f. Not subject to the single manufacturer requirement
2. Manufacturer shall be:
 - a. EZ-Path family of products by Specified Technologies Inc.
 - b. Hilti Firestop Speed Sleeve CP 653 Series

C. Firestopping for Backboxes in Fire-Rated Walls

1. Specifications
 - a. Used to seal backboxes in fire rated partitions.

- b. Minimum performance requirements: Shall meet UL testing requirements of UL 263 and classified as Wall Opening Protective Material (QCSN or CLIV); Shall be installed in accordance with the NRTL. Shall meet or exceed the ratings of the wall or floor that it is located in.
 - c. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
 - 2. Manufacturer shall be:
 - a. Hilti CP 617 or CFS-P PA
 - b. Specified Technologies Inc., SpecSeal Power Shield
 - c. Or equivalent from Conditionally Approved manufacturer.
- D. Firestopping for Thru-Wall (or Floor) Conduit Penetrations and Other Applications
 - 1. For fire-rated penetrations where the conduit pathway extends beyond a single fire-rated partition/floor, and other required firestopping applications not previously addressed in this specification.
 - 2. Specifications:
 - a. Shall be UL listed for the specific application; Shall meet or exceed the ratings of the wall or floor that it penetrates.
 - 3. Manufacturer shall be:
 - a. Hilti – submit UL System documentation for each floor/wall type and product cutsheets for all Hilti materials to be utilized
 - b. Specified Technologies Inc. – submit UL System documentation for each floor/wall type and product cutsheets for all STI materials to be utilized
 - c. Or equivalent from Conditionally Approved manufacturer.

2.4 ACCESS PANELS

A. Access Panels

- 1. Where pullboxes are required above inaccessible ceiling spaces, or for other required conditions, provide an appropriately-sized access panel. The following manufacturers are Conditionally Approved.
 - a. Activar/J.L Industries
 - b. Acudor Products
 - c. Alfab/Barco

- d. Elmdor Products
 - e. Karp Associates, Inc.
 - f. Milcor
 - g. Nystrom Building Products
 - h. Williams Brothers
 - i. Wind-lock
 - j. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)
2. Specifications:
- a. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation.
 - b. Joints and seams: continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
 - c. Frames: 16-gauge steel, with a 1 inch (25.4 mm) wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling:
 - 1) For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
 - 2) For gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - 3) For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
 - d. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - e. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
3. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.
4. Indicate proposed size and locations on pre-construction shop drawings. No access panels shall be installed without Architect and Design Consultant approval.

2.5 IDENTIFICATION FOR COMMON WORK FOR COMMUNICATIONS SYSTEMS

A. Labels

1. The following manufacturers are Conditionally Approved for generic labeling requirements for conduits, pullboxes, and equipment racks.
 - a. Brady
 - b. Brother
 - c. Dymo
 - d. HellermannTyton
 - e. Panduit
 - f. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)
2. Specifications:
 - a. Refer to additional requirements in Part 3 – Execution.
 - b. Refer to individual sections for additional identification requirements for specific work.

2.6 KEYS

- A. Supply two copies of every key as required for pullboxes, junction boxes, and access panels.

PART 3 - EXECUTION

3.1 PATHWAYS FOR COMMUNICATIONS

A. General

1. Refer to Electrical Division 26 for additional installation requirements.
 - a. Where a conflict exists between Division 26 and Division 27 the more stringent requirements shall apply.
2. All supports shall be specifically designed to support the required cable weight and volume. Field manufactured supports will not be accepted.
3. Install a pull cord in each pathway (empty or not) for installation of new wires or cables. Use polypropylene or monofilament plastic line with not less than 200 lb (90.7 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
4. Unless otherwise noted, pathway routing shown on the Drawings is illustrative only and meant to indicate the general configuration of the work. Install pathways so that adequate clearances and offsets between pathways and other trades are provided. Coordinate all pathways with other trades prior to installation.

5. All pathways shall include empty space for a minimum of 25% growth beyond initial installation of cabling when contractor performs conduit sizing calculations, otherwise follow conduit sizes indicated on drawings.
6. Cables shall be rigidly supported by cable pathways as indicated on the drawings. Cables shall be physically supported at intervals not to exceed 5 feet (1.52 m).
7. Store and keep dry all products in original container in a climate controlled environment until installation is to occur
8. Install all communications pathways:
 - a. So that cables are allowed to be pulled in accordance with referenced standards and guidelines.
 - b. So that cables are allowed to be pulled without damage to conductors, shield, armor, or jacket.
 - c. So that cables are not forced or allowed to exceed minimum allowed bend radius by manufacturer or referenced standards and guidelines.
 - d. So that the maximum allowable pulling tension is not exceeded.
 - e. To meet the requirements of the structure and the requirements of all other Work on the Project
 - f. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.
 - g. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Architect.
 - h. Parallel or perpendicular to building lines or column lines.
 - i. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
9. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or other methods shall **not** be used to attach cables to cable supports; UON.
 - a. Except when supported by ladder racking within each Telecommunications room, UON.
10. Provide adequate communications pathways so that cabling is not forced to attach, be supported, or use other pathways not specifically designed and provided for communications cabling purposes. Any deviation from this will not be accepted.
 - a. At no point shall cables come in contact with, be supported by, or attach to other trades equipment or supports. UON

- b. At no point shall cables come in contact with, be supported by, or attach to building structures or supports; UON
- 11. Provide appropriately sized sleeves where cables are required to pass through non-rated full-height partitions. Where allowed, sleeves shall extend a minimum of 3 inches (76.2 mm) beyond the partition surface on both sides, and shall be rigidly supported to support the weight of cables. Sleeves shall be sized so that no more than 50% of the cross-sectional area is utilized by the cabling to be installed. The minimum inside diameter of each sleeve shall be nominal 2 inches (50.8 mm).
- 12. Suspended cables shall be installed with at least 3 inches (76.2 mm) of clear vertical space above the ceiling tiles and support channels (T-bars).
- 13. Waterproofing
 - a. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.
 - b. Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the Owner.
- 14. Cutting and Patching
 - a. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, metalwork, etc. using skilled tradespeople of the trades required at no additional cost to the Owner.
 - b. Do not cut, channel, chase or drill masonry, tile, etc., unless permission from the Architect is obtained. If permission is granted, perform this work in a manner acceptable to the Architect.
 - c. Patch around all openings to match adjacent construction.
 - d. Where conduit or equipment is mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.
 - e. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Owner.
 - f. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.
- 15. Mounting Heights

- a. Mounting heights for equipment and devices requiring operational access shall conform to ADA requirements.
 - 1) Wall mounted devices requiring operational access shall be mounted a minimum of 15 inches above finished floor to bottom of device and a maximum of 48 inches above finished floor to top of device.
- b. Mounting heights shall be from floor to center of device, unless otherwise noted. Verify exact locations and mounting heights with the Architect before installation.
- c. Typical mounting heights shall match nearest adjacent typical electrical outlet mounting height UON or as directed by the Architect.

16. Painting

- a. Refer to Division 9 Section "Painting" for painting requirements.
- b. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.
- c. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
- d. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
- e. Where factory finishes are provided and no additional field painting is specified, touch-up or refinish, as required by, and to the acceptance of, the Architect and Design Consultant, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Architect or Design Consultant, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.
- f. Provide touch-up paint as required by Specification Sections in this Division.

17. Fastenings

- a. Fasten equipment to building structure in accordance with the best industry practice.
- b. Where weight applied to the attachment points is 100 pounds or less, conform to the following as a minimum:
 - 1) Wood: Wood screws.
 - 2) Concrete and solid masonry: Bolts and expansion shields.
 - 3) Hollow construction: Toggle bolts.
 - 4) Solid metal: Machine screws in tapped holes or with welded studs.

- 5) Steel decking or sub-floor: Fastenings as specified below for applied weights in excess of 100 pounds.
 - c. Where weight applied to building attachment points exceeds 100 pounds, but is 300 pounds or less, conform to the following as a minimum:
 - 1) At concrete slabs provide 24 inch x 24 inch x ½ inch steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top of slab screed line, where no fill is to be applied.
 - 2) At steel decking or sub-floor for all fastenings, provide through bolts or threaded rods. The tops of bolts or rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with his decking or sub-floor such hangers shall be provided.
 - d. Where weight applied to building attachment points exceeds 300 pounds, coordinate with and obtain the approval of Architect and conform to the following as a minimum:
 - 1) Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
 - e. For items, which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.
 - f. Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars. Prefabricated steel channels as manufactured by Kindorf or Unistrut are acceptable.
18. Areas identified as noise critical spaces shall have all penetrations sealed to minimize sound transmission between adjacent spaces. Install Acoustical Pathway(s) through walls of noise critical spaces
- B. Access to pathways and associated equipment
- 1. Locate all cable trays, open hanger cable supports, j-hooks, pull boxes, junction boxes and fire stopping systems so as to provide easy access for operation, service inspection and maintenance.
 - 2. Provide an Access Panel where equipment or devices are located above inaccessible ceilings. Where access doors are necessary but not shown on the plans, coordination type and location with Architect and Design Consultant through an RFI.
 - a. Pathways requiring access such as open hanger cable supports, j-hooks, and cable trays shall have an access door or other means of direct access at a minimum of 10 feet (3 m) intervals.
 - b. Cables or cable pathways requiring access such as open hanger cable supports, j-hooks, and cable trays may not change directions above an inaccessible ceiling unless complete

access to the change of direction in pathway or cable route is within arms reach 3 feet (0.9 m) from adjacent accessible point.

3. Maintain all code required clearances and clearances required by manufacturers.

C. Cable distribution

1. Provide pathways for Telecommunications (Structured Cabling System) to allow cabling to be installed in the following manner:
 - a. For typical new walls:
 - 1) Conduit from outlet location to accessible ceiling then j-hooks to main run of cable tray.
 - b. For existing walls:
 - 1) For stud walls - "Ring and String": Mud ring for faceplate, cabling run in hollow cavity of the wall and then j-hooks are utilized back to the nearest cable tray or serving Telecommunications Room/Space
 - 2) For masonry or inaccessible walls – Surface-mounted raceway to accessible ceiling space.
 - c. For phone and data lines to all Elevator Equipment Rooms and Fire Alarm panels:
 - 1) Homerun method: Conduit from outlet location all the way back to the Telecommunications Room/Space.
 - d. See drawings for clarification

D. Conduits

1. Conduit shall be of the appropriate type required by code and as required by Electrical Division 26]
2. Adequate access shall be available where cables enter conduits
3. Bond and ground all metallic conduits and boxes in accordance with national or local requirements and with TIA-607B – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
4. Install conduits in the most direct route possible, running parallel to building lines
5. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.
6. Conduits which enter Telecommunications rooms shall extend 3 inches (76.2 mm) AFF or through the wall.
7. Conduits which enter Entrance Facilities shall extend 4 inches (101.6 mm) AFF or below the finished ceiling (if exists).

8. Flexible conduits may only be used where specifically allowed by these contract documents.
 - a. Flexible conduit sections shall be less than 20 feet (6.1 m) in length.
9. No continuous section of a conduit may exceed 100 feet (30.5 m) without a pullbox.
10. For structured cabling, no more than (2) 90° bends, or equivalent will be allowed between pullboxes.
 - a. Each and any offset shall be considered a 90° bend.
 - b. A pullbox is required wherever a reverse bend is installed.
11. The minimum bend radius for conduits is
 - a. (6) times the inside diameter for 2 inches (50.8 mm) conduits or less.
 - b. (10) times the inside diameter for conduits greater than 2 inches (50.8 mm).
12. Any single conduit run may not serve more than (1) outlet location unless expressly indicated on the drawings.
13. Where building entrance conduits (for service provider and owner's WAN cabling) do not enter the building directly into the Communications Entrance Room/Facility, extend those entrance conduits via RMC or IMC into the Communications Entrance Room/Facility.
 - a. Coordinate with Contractor for Division 27 Sections "Communications Backbone Cabling" and "Communications Horizontal Cabling" for potential other pathways where IMC/RMC are required.
14. Conduits shall contain no electrical condulets (also known as LBs).
 - a. Exception: Pre-approved (by the Design Consultant) condulets specifically manufactured for communications cabling and will maintain minimum bend radius for cabling to be installed. These locations are to be called out on the shop drawings.
15. Underground Conduit Requirements
 - a. For Structured Cabling System horizontal cabling and pathways within the footprint of the building and serving voice and data outlets exterior to the building, such as emergency phones/towers, security cameras and wireless access points attached to exterior light poles, etc.
 - b. Requirements
 - 1) Refer to applicable details on drawings for illustrative requirements.
 - 2) Wherever practical, slab-on-grade floorboxes shall have conduit extended underground or in-slab from box to serving communications room or equipment cabinet.
 - a) Only one horizontal bend is allowed, 90 degrees or less.

- b) Indicate proposed routing and stub-up locations on shop drawings.
- 3) Route all underground conduit so there is no more than (3) 90 degree bends, including stub-up bend at communications room/equipment cabinet.
 - a) For underground conduit serving outlets/boxes outside the footprint of the building that require more than (3) 90 degree bends, provide appropriately-sized handhole(s). Coordinate location with Architect and Owner, indicate proposed location(s) on shop drawings, and include product information in pre-construction submittals. In general, handholes are not to be located in roadways, parking lots, sidewalks, or any location that may be subject to vehicular traffic.
- 4) Approved conduit types:
 - a) When routed in slab-on-grade:
 - i) Horizontal conduit shall be RMC or Schedule 40 PVC, including horizontal bends. If PVC is installed, also install tracer wire.
 - ii) Vertical bends shall be RMC.
 - b) When routed below slab-on-grade or outside the footprint of the building:
 - i) Horizontal conduit shall be RMC or Schedule 40 PVC a minimum of 12" below grade. If PVC is installed, also install tracer wire.
 - ii) All vertical and horizontal bends shall be RMC.
- 16. Install approved expansion/deflection fittings where raceways pass through or over building expansion joints.
- 17. Route raceway through roof openings for piping and ductwork or through roof seals approved by the Architect, the roofing contractor, or both. Obtain approval for all roof penetrations and seal types from the Architect, Owner, roofing contractor, or all three as required to maintain new or existing roofing warranties.

E. Outlet boxes

- 1. No outlet boxes shall be located back-to-back in a wall cavity.
 - a. Where possible offset to next stud cavity, with a minimum of 6 inch (152.4 mm) separation.
- 2. Outlet boxes shall be within 3 feet (0.9 m) of nearest electrical outlet.
- 3. Outlet boxes located in fire-rated walls are to have the appropriate firestopping for backboxes. These locations are to be identified on shop drawings.
- 4. Where cabling enters a backbox directly (not via conduit), provide black rubber grommet on knockout.

F. Pull Boxes

1. Pullboxes shall be placed in Conveniently Accessible locations.
2. Coordinate the location and installation of all pullboxes to ensure adequate access is provided.
3. Pullboxes above an accessible ceiling shall:
 - a. Be aligned directly over the ceiling grid to allow access
 - b. Be installed with a minimum of 3 inches (76.2 mm) clearance to ceiling grid and tiles
4. No directional changes shall be allowed in pullboxes. Conduit Shall continue in the same direction as it enters and then change direction via an appropriately sized bend in the conduit.
5. Size pullboxes according to the following chart (all sizes are minimums):

Conduit Trade Size	Width	Length	Depth	Width Increase for Additional Conduit (of same size)
3/4" or smaller	4"	4"	2-1/8"	Not applicable
1"	4"	16"	3"	2"
1-1/4"	6"	20"	3"	3"
1-1/2"	8"	28"	4"	4"
2"	8"	36"	4"	5"
2-1/2"	10"	42"	5"	6"
3"	12"	48"	5"	6"
4"	16"	60"	8"	6"

G. Cable Tray

1. Cable trays shall be installed in accordance with the applicable electrical code and standards.
2. The inside of the cable support system shall be free of burrs, sharp edges or projections that can damage cable insulation. Abrasive supports (e.g., threaded rod) installed within the cable fill area shall have that portion within the tray rigidly protected with a smooth, non-scratching covering so that cable can be pulled without physical damage such as appropriately rated (plenum) plastic tubing.
3. Cables shall remain unattached to its pathway and shall simply lay at rest on the supports provided by its pathway. Wire ties, velcro straps, electrical tape or other methods shall **not** be used to attach cables to cable supports; UON.
4. Installation of cables shall not exceed the fill requirements stated above.
5. Cable trays shall not extend through fire-rated walls and walls for noise critical spaces.

6. Cable trays shall not extend over 6' lengths (or greater) of inaccessible ceilings. Stop cable trays just before the inaccessible ceiling and provide overhead conduits of quantity and size bridging the two sections of cable tray so that conduit cable capacity (square inches per fill ratio) is equal to that of the cable tray.
 - a. The cable fill ratio for cable tray shall be 50%.
 - b. The cable fill ratio for conduits shall be 40%.
 - c. Example: a 4" x 12" cable tray has 48 square inches of total capacity, and 24 square inches of cable capacity. Per the NEC, a 4" trade size EMT conduit has a 40% cable capacity of 4.62 inches. 24 divided by 4.62, rounding up to the next whole number equals (6) 4" conduits shall be provided for a 4" x 12" cable tray.
7. Cable trays and cable runways shall not be used as walkways or ladders.
8. A minimum of 12 inches (300 mm) access headroom shall be provided and maintained above a cable tray system or cable runway.
9. Care shall be taken to ensure that other building components (e.g., air conditioning ducts, pipes, conduits) do not restrict access.
10. Flexible cable trays shall be supported according to manufacturer's instruction via one of the following:
 - a. Trapeze/Unistrut under the cable connected to the cable tray and to (2) 3/8" (or greater) rods to structure above.
 - 1) Center-hung, single-rod supports are not allowed.
 - b. Shelf or L-brackets attached to wood or metal studs.
11. Test cable tray systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with maximum grounding resistance.

3.2 LABELING

A. Labeling Installation

1. Labels that are to be secured by adhesive. They shall have a type of adhesive that is appropriate for the particular surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.

B. Labeling Requirements

1. Labels are to be installed on:
 - a. All firestopping systems. For wall and floor penetrations, label on both sides. See Firestopping later in this section.
 - b. All pathways (e.g., conduit, innerduct, etc.) installed under this work.

- 1) Label all conduit and innerduct with “TELECOM” or “AV” according to the intended system/use of the installed (or future) cabling. Conduit labels shall utilize text readable from a standing position on the finished floor. Conduit sleeves which pass through a single wall or floor need not be labeled.
 - a) For wall stub-up locations, label overhead only.
 - b) For conduits greater than 10', label both ends of conduit with far end location and Room/Number.
 - i) Example – “AV to AV Rack R01”.
 - c) For conduits that stub directly up or into a Communications Room, label both ends of conduit.
 - i) Example: underslab conduit from Telecom Room 1A to the Floor Box in Conference Room 101A shall be labeled as follows:
 - (1) Conduit stub-up location in Telecom Room 1A – “Telecom to Conf. Rm 101A Floorbox”
 - (2) Bottom of floorbox, immediately adjacent to serving Telecom conduit – “Telecom to Telecom Room 1A”
- 2) All pullboxes and junction boxes for Communications shall be labeled such as “TELECOM PULLBOX”, “AV JUNCTION BOX”, “TV”, etc. on the cover, such that the text is of sufficient size to be readable from a standing position on the finished floor.
 - a) Conduits entering and exiting all pullboxes and junction boxes shall be labeled with their destination/room number – ie “To AV Box Q:212:01 in Control Rm 212”.
- c. In general, the label is to be provided and installed by whomever installed the item that is being labeled.
- d. Refer to individual Division 27 Communications sections and to the drawings for additional information on labeling requirements.

3.3 FIRESTOPPING

A. General

1. Provide fire-resistant materials of a type and composition necessary to restore fire ratings to all wall, floor or ceiling penetrations; including membrane penetrations. All materials shall be classified or listed as a complete system by UL (or an approved NRTL by the Design Consultant and AHJ) and meet NEC and local codes. The use of partial systems or components of systems is not allowed unless specifically identified in the documents.
2. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of smoke, flame, toxic gas or water through the penetration before, during or after a fire. The fire

rating (F and T) of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by referenced building codes.

- a. Assume all floors are fire-rated, unless otherwise noted.
 - b. Also install fire stops at any other locations indicated in the Specifications or Drawings.
 3. Provide a label on both sides of fire rated assembly at all fire stop locations indicating:
 - a. Fire stop Manufacturer
 - b. Installer and company
 - c. Date installed
 - d. UL system number with all relevant ratings indicated
 4. Include labels in each telecom room in which one or more fire rated walls is installed. Provide a 2" block letter stencil label on the inside of the telecom room to indicate rating for each barrier.
 5. Provide systems as identified on the drawings and specified herein. At locations where the cabling routing encounters a fire-rated barrier provide an adequately sized fire stop device for the quantities and types for all cables to be installed plus 25% growth.
- B. Penetration Sealant – Conduits
1. Provide listed system to seal around openings between wall, floor or partition around conduits in accordance with system listing and manufacturer's instructions.
- C. Penetration Sealant – Voids, Cavities, and Openings
1. Install fire stop materials in the framed openings through fire rated partitions per the Architect's drawings and in accordance with the NRTL listed system instructions.
 2. Fire stop all voids, cavities, and openings left by the removal of cabling, conduits, conduit sleeves, cable trays or other equipment related to the communications systems not to be reused.
 3. Install the fire stop system in accordance with the manufacturer's instructions and local codes.
- D. Fire-Rated Pathway Device
1. Provide fire-rated pathway device anywhere cables are required to pass through fire-rated walls, floors or partitions.
 2. Devices shall be installed in locations where required by the Contract Drawings, arranged individually or appropriately ganged.
 3. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.

4. Apply the factory supplied gasketing material (where required) prior to the installation of the wall plates.
5. Secure wall plates (where required) to devices per the equipment manufacturer's recommendations.

END OF SECTION 270500

SECTION 270543 - UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes:

1. Raceways, fittings, boxes, handholes, and manholes for direct buried and concrete-encased communications distribution pathways.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING:

- A. Division 26 Sections "General Electrical Requirements" and "Common Work Results for Electrical" for general requirements and related documents that apply to this Section.
- B. Division 27 Section "General Communications Requirements" for general requirements and related documents that apply to this Section.
- C. Division 27 Section "Common Work Results for Communications" for limited scope general construction materials and methods.
- D. Division 31 Sections, including "Earth Moving".
- E. Division 32 Sections, including "Turf and Grasses and "Plants".

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 27 Section "General Communications Requirements":

1. Product data for the following products:
 - a. Raceways, Raceway fittings, separators, and accessories, duct-bank materials, manholes/handholes, solvent cement, sealants, tracer wire, warning tape / warning planks.
2. Shop drawings for:
 - a. Detailing fabrication and installation for custom manholes or handholes including duct entry provisions, reinforcing details, frame and cover design, manhole frame support rings, ladder details, grounding details, sump details, joint details, and cable racks, pulling irons, lifting irons.
 - b. Detailing of pathway and placement of manhole/handhole devices for underground duct bank pathways.

- B. Record Drawings: Submit Record Drawings as required by Division 01 and Division 27 Section “General Communications Requirements”:
1. Accurately record actual routing of all exterior buried raceway including coordination with other surrounding utilities and underground structures. Provide scaled plans and sections that indicate dimensions from finished grade or other fixed structural elements for all components of the pathway (duct bank sizing and location, conduit quantities and placement within the duct bank, tracer wire locations and sizing, warning plank location and sizing, manhole/handhole placement as well as sizing of each manhole/handhole installed).

1.4 DEFINITIONS

- A. Terminology used in this specification is as defined below:
1. GRS: Galvanized Rigid Steel Conduit
 2. RMC: Rigid Metal Conduit
 3. RNC: Rigid Nonmetallic Conduit
- B. Refer to Division 27 Section “General Communications Requirements” for additional abbreviations / definitions.

1.5 CODE, STANDARDS, AND GUIDELINES

- A. The following codes and standards contain provisions that, through reference in this text, constitute provisions of document. At the time of publication the editions indicated were valid. All equipment, construction practices, design principles, and installation shall conform to the latest version of any or all of the following standards and codes published by the following organizations, where applicable
1. Federal Communications Commission (FCC)
 2. Institute of Electrical and Electronics Engineers, Inc (IEEE)
 3. National Fire Protection Association (NFPA)
 4. National Electric Code (NEC)
 5. American National Standards Institute (ANSI)
 6. Telecommunications Industry Association (TIA)
 7. Electronics Components Industries Association (ECIA)
 8. Building Industry Consulting Service International (BICSI)
 9. National Electrical Contractors Association (NECA)

10. International Building Code (IBC)
 11. FCC Regulations Part 68
 12. NPFA-70 National Electrical Code Chapter 8 – Communications Systems
 13. NFPA-71 Central Signaling Systems
 14. NFPA-780 Protection of Electronic and Computer Data Processing Equipment
 15. NFPA-780 Lightning Protection Code
 16. NFPA-101 Life Safety Code
 17. ANSI/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces
 18. TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 19. TIA-STD-J-607 Commercial Building Bonding and Grounding requirements for Telecommunications
 20. ANSI/NESC – National Electrical Safety Code
- B. All equipment, construction practices, design principles, and installation shall conform to the latest version of any or all of the following guidelines published by the following organizations, where applicable
1. BICSI Methodologies
 - a. BICSI Telecommunications Distribution Methods Manual
 - b. BICSI ITS Installation Methods Manual
 - c. Customer Owned Outside Plant Design Manual
- C. Additional requirements for Manholes and Handholes:
1. Manholes shall be designed in compliance with the following ASTM standards:
 - a. ASTM C857-87 “Standard Practice for Minimum Structural Design Loading for Underground Pre-cast Concrete Utility Structures”,
 - b. ASTM C478 “Standard Specification for Pre-cast Reinforced Concrete Manhole Sections”,
 - c. ASTM C858-83 “Standard Specifications for Underground Pre-Cast Concrete Utility Structures”
 - d. All reinforcing steel shall conform to ASATM 432 “Standard Guide for Selection of a Leak Testing Method” and

- e. ASTM 305 “Standard Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency”.
 - f. ASTM C990, “Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants”
 - g. ASTM 432, “Standard Guide for Selection of a Leak Testing Method:
 - h. Test and inspect pre-cast concrete utility structures according to ASTM C 1037
- 2. Manholes to be designed per ACI 318-02 “Building Code Requirements for Structural Concrete”.
 - 3. Test and inspect pre-cast concrete utility structures according to ASTM C 1037
 - 4. 4.Non-concrete Handholes and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77.

1.6 QUALITY ASSURANCE

- A. Pre-cast concrete manholes to be manufactured at a plant that holds a current NPCA certification Pre-cast concrete manholes to be manufactured at a plant that holds a current NPCA certification.
- B. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 5 years.
- C. Communications and Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
 - 2. Marked for intended use.
- D. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards
- E. Refer to Division 27 Section “General Communications Requirements” for additional Quality Assurance requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 COORDINATION

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

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- B. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.2 RACEWAYS AND FITTINGS

- A. Metal Conduit
 - 1. Manufacturers:
 - a. AFC Cable Systems, Inc.
 - b. Alfex Corporation, a Southwire Company
 - c. Anamet Electrical, Inc.; Anaconda Metal Hose.

- d. Electri-Flex Co.
 - e. Indalex
 - f. Manhattan/CDT/Cole-Flex
 - g. O-Z/Gedney; Unit of General Signal (Fittings)
 - h. Republic Raceway
 - i. Tyco International; Allied Tube & Conduit Div.
 - j. Wheatland Tube Co.
 - k. Or approved equivalent
2. RMC:
- a. GRS: Hot-dip galvanized steel (including threads): ANSI C80.1, UL 6
 - b. Fittings: NEMA FB 1; compatible with raceway and tubing materials.
- B. Nonmetallic Raceway
1. Manufacturers:
- a. AFC Cable Systems, Inc.
 - b. American International.
 - c. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - d. Aruco Corp.
 - e. Cantex Inc.
 - f. Certainteed Corp.; Pipe & Plastics Group.
 - g. Condux International.
 - h. ElecSYS, Inc.
 - i. Electri-Flex Co.
 - j. Lamson & Sessions; Carlon Electrical Products.
 - k. Manhattan/CDT/Cole-Flex.
 - l. RACO; Division of Hubbell, Inc.

- m. Spiralduct, Inc./AFC Cable Systems, Inc.
 - n. Superflex Ltd.
 - o. Thomas & Betts Corporation.
 - 2. RNC: Extra-heavy Schedule 80 conduit type EPC-80-PVC, PVC: NEMA TC 2, UL 651.
 - a. Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable and UL listed for direct burial as well as above ground use.
 - 3. RNC: Heavy Schedule 40 conduit type EPC-40-PVC, PVC: NEMA TC 2, UL 651.
 - a. Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable and UL listed for direct burial as well as above ground use.
- C. Duct Accessories
- 1. Innerduct
 - a. Install size and quantity of innerduct within conduits as identified on the drawings.
 - b. Requirements:
 - 1) Suitable for installation within the installed conduits
 - 2) Sequential foot markings
 - 3) Material shall be corrugated High Density Polyethylene (HDPE)
 - 4) Manufacturer shall be: Duraline Corrugated, or approved equivalent
 - 2. Duct Separators shall be factory-fabricated rigid interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 - 3. Underground-line warning tape / tracer wire:
 - a. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 - 1) Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
 - 2) Compounded for permanent direct-burial service.
 - 3) Embedded continuous metallic strip or core.
 - 4) Printed legend shall indicate type of underground line.
 - 4. Refer to details on drawings for additional accessories.

2.3 PRE-CAST CONCRETE HANDHOLES AND BOXES

A. General

1. Manufacturers:

- a. Carder Concrete Products.
- b. Christy Concrete Products
- c. Elmhurst-Chicago Stone Co.
- d. Oldcastle Pre-cast Group
- e. Riverton Concrete Products; a division of Cretex Companies, Inc.
- f. Utility Concrete Products, LLC
- g. Utility Vault Co.
- h. Wausau Title, Inc.
- i. Or Approved Equivalent

B. Comply with ASTM C858 for design and manufacturing process.

C. Pre-cast concrete handholes and boxes shall be factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of the handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. The cover finish shall be a nonskid finish with a minimum coefficient of friction of 0.50.
3. The cover shall have the following legend lettering molded into the cover:
 - a. "COMMUNICATIONS" for Telecommunications spaces
4. Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
5. Extensions and slabs shall be designed to mate with bottom of enclosure and shall be same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches.
 - b. Slab shall be same dimensions as bottom of enclosure, and arranged to provide closure.

6. Windows shall be included as pre-cast openings in walls arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window openings shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No.4 steel reinforcing bars in concrete around each opening.
7. Duct entrances into handhole walls shall have cast end-bell or duct-terminating fittings in the wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable
 - c. Rigid steel conduits shall be hot-dipped galvanized malleable iron or steel threaded to the end if the conduit is cast in place in the wall of the manhole. .
8. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
9. A clamped bonding ribbon shall be attached to rebar prior to encasement by concrete. Bonding ribbon shall exit manhole/handhole wall within 12" of top and between wall-mounted cable racks. Length shall be sufficient to attach to Ground Rod that stubs up 4" through manhole/handhole floor. Refer to detail on drawings and Chapter 6 of BICSI Outside Plant Manual for more information.

2.4 GROUNDING

A. Ground Rods: UL-listed:

1. Copper-clad steel; bonded copper electrolytically-applied to minimum thickness of 10 mils.
2. 3/4" thick, by 10' long
3. Manufacturer shall be:
 - a. Copperweld Steel Company
 - b. ITT Weaver
 - c. Thomas & Betts

d. Pre-Approved equal.

B. Grounding Conductors and Connectors

1. Manufacturers:

- a. Apache Grounding/Erco Inc.
- b. Boggs, Inc.
- c. Chance/Hubbell.
- d. Copperweld Corp.
- e. Dossert Corp.
- f. Erco Inc.; Electrical Products Group.
- g. FCI/Burndy Electrical.
- h. Galvan Industries, Inc.
- i. Harger Lightning Protection, Inc.
- j. Hastings Fiber Glass Products, Inc.
- k. Heary Brothers Lightning Protection Co.
- l. Ideal Industries, Inc.
- m. ILSCO.
- n. Kearney/Cooper Power Systems.
- o. Korns: C. C. Korns Co.; Division of Robroy Industries.
- p. Lightning Master Corp.
- q. Lyncole XIT Grounding.
- r. O-Z/Gedney Co.; a business of the EGS Electrical Group.
- s. Panduit, Inc
- t. Racor, Inc.; Division of Hubbell.
- u. Robbins Lightning, Inc.
- v. Salisbury: W. H. Salisbury & Co.

- w. Superior Grounding Systems, Inc.
 - x. Thomas & Betts, Electrical.
 - y. Or approved equivalent
2. Grounding Conductors
- a. Grounding Electrode Conductors: Bare, stranded, unless otherwise indicated.
 - b. Underground Conductors: Tinned-copper conductor, No. 2/0 AWG minimum stranded, unless otherwise indicated.
 - c. Bare Copper Conductors: Comply with the following:
 - 1) Solid Conductors: ASTM B 3.
 - 2) Assembly of Stranded Conductors: ASTM B 8.
 - 3) Tinned Conductors: ASTM B 33.
 - d. Copper Bonding Conductors: As follows:
 - 1) Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
 - 2) Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
 - 3) Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
3. Connector Products
- a. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
 - b. Bolted Connectors: Bolted-pressure-type connectors
 - 1) Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM 8 1 87, essentially the same as the conductors being connected; clearly and permanently marked with the information listed below:
 - a) Company symbol and/or logo.
 - b) Catalog number.
 - c) Conductors accommodated.
 - d) Installation die index number or die catalog number is required.

- e) Underwriters Laboratories “Listing Mark:”.
 - f) The words “Suitable for Direct Burial” or, where space is limited, “Direct Burial” or “Burial” per UL Standard ANSI/UL467 (latest revision).
- 2) Cast connectors: copper base alloy according to ASTM B 30 (latest revision).
- c. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer’s instructions.

3.2 UNDERGROUND ENCLOSURE INSTALLATION

- A. Handholes and boxes Telephone, Communications, and Data Wiring:

1. Units in roadways and Other Deliberate Traffic Paths: Pre-cast concrete. AASHTO HB H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Pre-cast Concrete, AASHTO HB 17, H-20 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate loading by Vehicles: Pre-cast Concrete, AASHTO HB 17, H-10 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced Polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading
5. Handholes shall be used as pull-through points only. Handholes shall not be used as splice points, unless authorized in writing by ASU UTO.
6. Handholes shall not be used in conduit runs that have more than (3) three 4” conduits.
7. Joint use of handholes by other trades is not allowed.

- B. Manholes: Pre-cast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

3.3 EARTHWORK

- A. Excavation and Backfilling: Comply with Division 31 Section “Earth Moving” but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling and compaction is complete.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections “Turf and Grasses and “Plants”.
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section “Cutting and Patching”.

3.4 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- A. Precast Concrete Handhole and Manhole Installation:
 - 1. Comply with ASTM C891, unless otherwise indicated.
 - 2. Install each unit level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
- B. Elevations:
 - 1. Install manholes / handholes per manufacturer's instructions; lid to manhole / handhole to be flush with the surrounding terrain so that no earth, roadway or sidewalk removal is required to access the manhole / handhole interior. Contractor to provide chimney/ extensions / collars to facilitate the placement of the manholes / handholes so as to maintain the minimum distance to the surface above the highest row of conduits in the duct bank given the location of the manhole / handhole at the point of installation.
 - 2. Manhole Roof: Install with rooftop at least 15-inches below finished grade.
 - 3. Install handholes with bottom below the frost line, below grade.
 - 4. Handhole Covers: Set surface flush with finished grade.
- C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
 - 1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.

2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
- E. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days
- F. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- G. Hardware: Install removable hardware, including pulling eye, cable stanchions, cable arms, and insulators, as required for installation and support of cable and conductors and as indicated.
- H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8-inches for manholes and 2-inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- J. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover

3.5 GROUNDING

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

2. Underground Grounding Conductors: Bury at least 24 inches below grade, or 6 inches below the official frost line, whichever is greater, or when crossing a duct bank, bury 12 inches above duct bank.

D. Connections

1. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulating tape, heat shrinkable insulating tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.
 - a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - b. Make connections with clean, bare metal at points of contact.
 - c. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - d. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
2. Compression Fittings: Permanent compression-type fittings may be used for the following:
 - a. Connecting conductors together.
 - b. Connecting conductors to ground rods
3. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A/B.
4. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
5. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

E. Field Quality Control

1. Testing: Perform the following field quality-control testing:

- a. Test completed grounding system at each location. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
- b. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- c. Perform point-to-point megohmmeter tests between the ground rod and all cable shields, splice cases, locate wires, and racking hardware to determine the resistance.
- d. Investigate point-to-point resistance values that exceed 0.5 ohms.
 - 1) Check for loose connections.
 - 2) Check for absent or broken connections.
 - 3) Check for poor quality welds.
 - 4) Consider other reasons.
- e. Excessive Grounding Electrode Resistance: If measured resistance to earth ground value exceeds specified values, notify Architect promptly and include recommendations and costs to reduce them.

3.6 GRADING AND PLANTING

- A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 31 and 32. Maintain restored surfaces. Restore disturbed paving as indicated.

3.7 INSTALLATION ACCEPTANCE

- A. Prior to final acceptance of the duct bank and associated structures, pull an aluminum or wooden test mandrel through the duct to prove joint integrity and to verify ducts have not been deformed. Provide mandrel equal to 80 percent fill of the duct internal diameter.
- B. Test duct bank, manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified above. Correct any deficiencies and retest as specified above.

- C. Clean internal surfaces of manholes (including sumps) and handholes and remove foreign materials.
- D. Acquire written approval from the Owner prior to backfilling any duct banks or covering manholes / hand holes
- E. Provide Record Drawings indicating the exact pathway of the Telecommunications Duct bank include elevation changes and the location of all manholes/handholes. Label all manholes MH-xx and handholes HH-xx, coordinating exact labeling scheme with Owner.

END OF SECTION 270543

SECTION 271000 - STRUCTURED CABLING SYSTEM

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. Provide a complete functioning telecommunications structured cabling system, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.
- B. Specification sections 271000 through 271999, and Drawings numbered with prefixes TN, generally describe these systems, but the scope of the Structured Cabling System Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical, Communications, and Electronic Safety and Security Drawings and Specifications; and Addenda.
- C. This section includes additional requirements for the Structured Cabling (Telecommunications) System, which include the following:
 - 1. Quality Assurance requirements, including Contractor qualifications and advanced warranties

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Division 27 Section "General Communications".
- C. Division 27 Section "Common Work Results for Communications".
- D. Requirements of this Section apply to all Sections 271000 through 271999.

1.3 STANDARDS

- A. The references to the following standards represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the correct revision or printing (UON):
 - 1. ANSI/TIA-568 – "Commercial Building Telecommunications Cabling Standard Set"
 - 2. ANSI/TIA-569 – "Commercial Building Standard for Telecommunications Pathways and Spaces"

3. TIA-526 – “Standard Test Procedures for Fiber Optic Systems”
4. TIA TSB 140 – “Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems”
5. ANSI/TIA-606 – “Administration Standard for Commercial Telecommunications Infrastructure
6. ANSI/TIA-607 – “Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises”
7. ANSI/BICSI/NECA 568 – “Standard for Installing Commercial Building Telecommunications Cabling”
8. ANSI/BICSI-001 “Information Transport Systems Design Standard for K-12 Educational Institutions”

1.4 GUIDELINES

- A. The references to the following guidelines represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the correct revision or printing (UON)
 1. BICSI Information Technology Systems Installation Methods Manual (ITSIMM)
 2. BICSI Telecommunications Distribution Methods Manual (TDMM)

1.5 DEFINITIONS

- A. Structured Cabling System – the physical infrastructure installed to support information technology/transport for voice and data applications, commonly referred to as a Telecommunications System. This includes, but is not limited to: Category 3/5e/6/6A copper cabling, terminations/blocks, modules, faceplates, etc., and optical fiber cabling, terminations, modules, etc.
- B. Wet Location - as defined in the NEC, installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

1.6 QUALITY ASSURANCE

- A. Personnel Qualifications:
 1. Provide and maintain a BICSI Registered RCDD in good standing on staff as a full-time employee at all times. This RCDD shall be familiar with the project and available to attend all scheduled project meetings when required by the Owner/Design Consultant.
 2. Provide and maintain a Project Manager whom is a BICSI Registered Certified Technician Level 2 Installer in good standing on site at all times. This project manager shall attend all scheduled project meetings and be responsible for all Submittals.

3. The person(s) conducting the testing for all Telecommunications cabling shall be a current BICSI Certified Level II Commercial Installer or higher.
4. Any additional personnel that will be physically installing any part of the Telecommunications Infrastructure covered by this Division shall, at a minimum, be a BICSI Certified Level 1 Commercial Installer in good standing or have equivalent manufacturer training certificate (of those identified as approved for this project) and approved by the Design Consultant.
5. These requirements are provided as a minimum level of qualification. Any additional or more stringent requirements by the specific manufacturer chosen to provide the proper level or term of warranty as specified in this division shall be met.
6. Alternate qualifications may be considered if requested alternates are provided in accordance with the substitution section herein prior to bid.

B. Contractor qualifications:

1. Provide a list of projects (no less than 2) of similar size, scope and type in which the Bidder has performed in a capacity comparable to the size, scope and type outlined in these Construction Documents. Provide the project name, relevant project information for comparison evaluation, and contact names with telephone numbers of each such project.

1.7 ADVANCED STRUCTURED CABLING SYSTEM WARRANTY

- A. All components, including but not limited to, connectors, terminal blocks, cabling and all other components considered to be a part of what is commonly referred to as an end-to-end solution for all backbone and horizontal cabling systems, shall be warranted for a minimum period of 15 years from the date of installation against defects in materials, equipment and workmanship. This warranty shall also include the performance of these systems. This warranty shall include transmission requirements as specified in applicable ANSI/TIA/IEC/ISO standards for each cable system specified. This warranty shall also include all current and future applications designed for and becomes available under warranty for each cable system.

1. Warranty shall be guaranteed by a single reputable manufacturer such as:
 - a. Belden Incorporated
 - b. CommScope Inc.
 - c. Hubbell
 - d. Legrand/Ortronics
 - e. Leviton
 - f. Panduit
 - g. Siemon
 - h. Superior Essex Cabling

i. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)

- B. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.
- C. Perform the remedial work promptly, upon written notice from the Architect or Owner.
- D. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.8 WORK INCLUDED

- A. Provide labor, materials, and accessories required to provide complete, operating Telecommunications Infrastructure systems as called for in the Contract Documents and in accordance with applicable codes and regulations. Labor, materials or accessories not specifically called for in the Contract Documents, but required to provide complete, operating infrastructure systems shall be provided without additional cost to the Owner. The work includes, but is not necessarily limited to, the following:
 - 1. All horizontal cabling between the Telecommunications rooms and the outlets.
 - 2. All backbone cabling, including cabling between the Telecommunications Entrance Facility Room and the Telecommunications rooms and designated Telecommunications equipment rooms.
 - 3. All termination blocks, outlets/jacks, patch panels, cabinets, equipment racks, etc., required to support, terminate and/or cross connect cabling at the main cross-connect, Telecommunication rooms and/or other designated equipment locations.
 - 4. All physical cable management hardware including, but not limited to: “J-hooks” in accessible ceiling areas, cable trays, conduits, ladder-type cable racks within telecommunication rooms and “D-rings” on backboards and equipment racks/cabinets/frames.
 - 5. A Grounding/Bonding System, as described in these construction documents.
 - 6. Termination, cross connect and patching of all cable pairs as indicated herein or on schedules or on drawings.
 - 7. Testing, labeling and documentation of all cables and hardware installed under this contract.
 - 8. Preparation and submission of shop drawings, testing reports, as-built drawings, and cabling documentation as described below.

1.9 COORDINATION

- A. The locations of cable termination fields, outlets, patch panels, equipment racks and other equipment indicated on the Drawings are approximately correct, but they are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed in consequence of

increase or reduction of the number of outlets, or in order to meet field conditions, or to coordinate with modular requirements of ceilings, or to simplify the work, or for other legitimate causes.

- B. Exercise particular caution with reference to the location of outlets, patch panels, control panels, switches, etc., and have precise and definite locations accepted by the Architect before proceeding with the installation.
- C. The Drawings show only the general run of raceways and approximate locations of outlets. Any significant changes in location of outlets, cabinets, etc., necessary in order to meet field conditions shall be brought to the immediate attention of the Architect for review before such alterations are made. Modifications shall be made at no additional cost to the Owner.
- D. Verify with the Architect the exact location and mounting height of outlets and equipment not dimensionally located on the Drawings.
- E. Outlet/cable tags in the form of alpha/numeric characters are used where shown to indicate the outlet and cable designation numbers in cable termination fields (terminal blocks and/or patch panels. Show the actual outlet/cable numbers on the as-built drawings, on the associated typed termination field labels and in the printed and computer readable cabling schedules. Where sample outlet/cable-numbering information is not indicated, request clarification from the Architect.
- F. The drawings generally do not indicate the number of cables in conduit, or the actual identity of cables in specific conduits, cable tray or other cabling pathways. Provide the correct cable type and quantity as required by the indicated outlets, cable schedules, the design intent of any example drawings or schedules, referenced wiring diagrams (if any), the maximum distance limitations, and the applicable requirements of the NEC and ANSI/TIA-568.
- G. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.
 - 1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
 - 2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.

1.10 SUBMITTALS

- A. Refer to requirements in Division 27 Section “General Communications Requirements”. At a minimum, include the following items:
 - 1. “Pre-bid” Phase
 - a. Product substitutions, approved alternate or equivalent requests to be reviewed for approval (Prior to Bid)
 - b. Alternate personnel credentials to be reviewed for approval

2. “Bid” Phase

a. Bid Response Forms

b. Personnel Qualifications / Credentials - Supplemental to Division 1 requirements submit the following documents to indicate the required personnel qualifications per the quality assurance section of this section:

1) Member of staff required to be RCDD

- a) A copy of their valid RCDD certificate, RCDD number, and BICSI member number shall be provided with bidding documents.

2) On-site project manager

- a) A copy of their valid BICSI Certified Technician certificate and BICSI member number shall be provided with bidding documents.

3) Other personnel physically installing any portion of the Communications infrastructure

- a) A copy of their valid BICSI Commercial Installer certificate and BICSI member number shall be provided with bidding documents

- b) An alternate certification may be considered by the Design Consultant for approval, which shall be completely at the Design Consultant's discretion.

- c) If the contractor chooses to submit an alternate certification from one of the conditionally approved vendor list as an acceptable alternate for a BICSI Commercial Installer, the following shall be included:

- i) A valid copy of each certification with the person's name and member number including the manufacturer's logo

- ii) A document provided by the manufacturer describing what specific subjects the certification covers, period of time spent doing course work required to gain certification, exam topics, and the requirements needed to maintain the certification.

4) Contractor Qualifications (Previous project references)

5) Voluntary Bid Alternates

3. “Pre-construction” Phase

a. Warranty information

- 1) Sample warranty certificate for the Advanced System Warranty, indicating manufacturer and terms/conditions

- 2) Proof that Contractor is certified with the Advanced System Warranty manufacturer

- b. Resubmit Contractor and Personnel Qualification, update if necessary
 - c. A typed list, indexed by Specification section, of products specifically identified by part number (no wild card characters) within each specification section in this Division. Order shall match that as in these specifications.
 - d. Manufacturers' cut-sheets, in same order as typed list and in these specifications.
 - 1) At a minimum all cut-sheets shall contain the following:
 - a) Cross-reference to the specification section and/or drawings for which the product is to be reviewed for compliance and acceptance
 - b) Every product cut-sheet submitted for review shall contain the manufacturers' name and logo
 - c) All parts, pieces, and equipment submitted for review shall be identified specifically by stamp, or highlighted in such a manner that the product(s) being considered are clearly identifiable and distinguished from all other materials, parts or equipment that may be on the submittal.
 - d) For cut-sheets with accessories, additional parts, or derivations of the product being submitted all shall be clearly identified for the reviewer and acceptance.
 - e) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL listings, approval or certification information, and other necessary identifying information to confirm product meets specifications.
 - e. Shop Drawings
 - f. And as required by individual sections in this Division
4. Phase four - "Project Completion"
- a. Preliminary Project Completion submittal requirements:
 - 1) To be submitted:
 - a) After all horizontal and backbone cabling has been installed, terminated, labeled, tested, and corrected so that all cables and strands pass the Testing Requirements.
 - b) In conjunction with the Substantial Completion Review request.
 - i) Design Consultant requires a minimum of 2 weeks notice to schedule the on-site Substantial Completion Review.
 - ii) Substantial Completion Review shall be a minimum of 1 weeks before Substantial Completion, or earlier if the Project Schedule requires it, to allow for major Punch List items to be address by Contractor.

- 2) Submittal shall include:
 - a) Scanned Work Site Prints that include horizontal and backbone cable/outlet labels that correspond to the Test Results.
 - b) Passing Test Results for all cables and strands, in the following formats:
 - i) Abbreviated Test Results in Excel or CVS file format, shown in numerical/alphabetical order, with the following information:
 - (1) Project Name
 - (2) Date of Preparation
 - (3) ID of Work Area Outlet / connector being tested
 - (4) Date of test
 - (5) Contractor's Name
 - (6) Media Type
 - (7) Make, Model, and Serial Number of test equipment used
 - (8) Date of last calibration
 - (9) Names of test crew
 - (10) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
 - (11) Category or type of cable being tested
 - (12) Pass or Fail status
 - ii) Full Test Results in the original file format of the tester (example: .mdb file), shown in numerical/alphabetical order, with the following information:
 - (1) Project Name
 - (2) Date of Preparation
 - (3) ID of Work Area Outlet / connector being tested
 - (4) Date of test
 - (5) Contractor's Name
 - (6) Media Type

- (7) Make, Model, and Serial Number of test equipment used
- (8) Date of last calibration
- (9) Names of test crew
- (10) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
- (11) Category or type of cable being tested
- (12) Full Test Result Data (per Part 3 of this specification)

b. Final Project Completion submittal requirements:

- 1) Advanced Structured Cabling System Warranty Certificate. Warranty terms and conditions shall contain the following:
 - a) Length of warranty period
 - b) Applications covered (future and present)
 - c) Single manufacturer responsible for fulfilling warranty
 - d) Who is covered
 - e) What is covered
 - f) All disclaimers, limitations, etc.
 - g) What, if anything, is not covered
- 2) Product Information
 - a) Product List (Bill of Materials) – a typed list of products (in order of these specifications), in Excel or CSV file format, indicating:
 - i) Product Type (as identified in these specifications)
 - ii) Manufacturer
 - iii) Model Number
 - iv) Quantity installed
 - v) Serial Number (if applicable)
 - vi) Manufacturer Warranty date (if longer than 1 year)
 - b) Manufacturer Cut Sheets / Specification Sheets

- c) Operation and Maintenance Manuals – manufacturer's installation, service, and maintenance instructions.
 - d) Warranty certificates (for products not covered by the Advanced System Warranty)
 - i) If products require registration, register on the Owner's behalf.
- 3) As Built Drawings
 - a) At the completion of the project, incorporate changes to the Structured Cabling System noted on the jobsite work prints onto a set of as built Drawings. These changes shall be done electronically in AutoCAD and saved to PDF and AutoCAD 2007 dwg format.
 - b) Include date and installing contractor's logo and contact information in the title block.
 - c) Mark each sheet "As Built Drawing".
 - d) Drawings shall include:
 - i) Corrected items from Substantial Completion Review punch list.
 - ii) Cable ID (all characters) for each work area outlet jack (so that they are searchable in the PDF version)
 - iii) Routing of cable/conduit/cable tray and location of any firestopping systems and pull boxes.
- 4) Updated, complete Test Results in the following formats (to include the retesting data of any cables installed or modified after Preliminary Project Completion submittal):
 - a) Abbreviated Test Results in Excel or CVS file format, shown in numerical/alphabetical order, with the following information:
 - i) Project Name
 - ii) Date of Preparation
 - iii) ID of Work Area Outlet / connector being tested
 - iv) Date of test
 - v) Contractor's Name
 - vi) Media Type
 - vii) Make, Model, and Serial Number of test equipment used

- viii) Date of last calibration
- ix) Names of test crew
- x) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
- xi) Category or type of cable being tested
- xii) Pass or Fail status
- b) Full Test Results in the original file format of the tester (example: .mdb file), shown in numerical/alphabetical order, with the following information:
 - i) Project Name
 - ii) Date of Preparation
 - iii) ID of Work Area Outlet / connector being tested
 - iv) Date of test
 - v) Contractor's Name
 - vi) Media Type
 - vii) Make, Model, and Serial Number of test equipment used
 - viii) Date of last calibration
 - ix) Names of test crew
 - x) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
 - xi) Category or type of cable being tested
 - xii) Full Test Result Data (per Part 3 of this specification)
- B. All submittals for Division 271000 through 271999 (Structured Cabling System) work at each phase shall be submitted together and in one package. "Piecemeal" submissions will not be reviewed. It is permissible to combine 270500 Common Work Results submittals with that of the Structured Cabling System.
- C. For each room or area of the building containing Structured Cabling System infrastructure and equipment, submit the following as part of the shop-drawings and as-built drawings:
 - 1. Floor plans, at not less than 1/8" scale, showing routing of Communications conduits, cable trays, and wireways, including surface-mounted raceways and pullboxes. Also show the routing of

bundles of cables supported by "J-hooks", or similar means, if and where such installation practices are allowed by the Contract Documents.

- a. Outlet locations shall be identified with jack/module type and label. Coordinate labeling scheme with Owner prior to submitting.
2. Riser diagrams showing types, quantities and schematic routing of all Communications backbone pathways, cabling and the TBB and BCT.
3. Enlarged plan views and elevation layout drawings for the Telecommunications Entrance Facility Room, Telecommunications Rooms and all other designated Telecommunications Equipment Rooms indicating the equipment in the exact location in which it is intended to be installed. These plans shall be of a scale not less than $\frac{1}{4}$ inch = 1'-0". They shall be prepared in the following manner:
 - a. Indicate the physical boundaries of the space including door swings and ceiling heights and ceiling types (as applicable).
 - b. Illustrate all Communications equipment proposed to be contained therein. The Drawings shall be prepared utilizing the dimensions contained in the individual equipment submittals. Indicate code and manufacturer's required clearances.
 - c. Illustrate all other equipment therein such as conduits, detectors, lighting fixtures, ducts, registers, pull boxes, wireways, structural elements, etc.
 - d. Indicate the operating weight of each piece of equipment.
 - e. Indicate dimensions to confirm compliance with code-required clearances.
 - f. Indicate maximum normal allowable operating temperature for each piece of equipment (as per each respective manufacturer's recommendation). (Note: This requirement applies to active Communications equipment such as LAN hubs, routers, amplifiers, radio transmitters/receivers, PBX or key telephone equipment, etc., if installed under this work.)
 - g. Equipment removal routes for individual equipment items with plan dimensions exceeding 24" by 36" or height exceeding 84".
- D. The Communications Equipment room layout submittals and the related Structured Cabling System submittals shall be submitted concurrently. Failure to submit concurrently may result in the immediate return of the submittal marked REVISE AND RESUBMIT.

PART 2 - PRODUCTS

2.1 110-STYLE PUNCHDOWN TOOL

- A. Manufacturer shall be: Panduit PDT-110 or equivalent.

2.2 COPPER TESTING EQUIPMENT

A. Category 3/5e Cable Tester

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.
 - a. Category 3/5e UTP cable Tester
 - 1) Fluke
 - 2) Ideal
 - 3) Softing
 - 4) Viavi
2. Requirements
 - a. The field tester shall be a level II-E (IIe) or greater.
 - b. The field tester shall meet the requirements of ANSI/TIA-568.

B. Category 6 Cable Tester

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.
 - a. Category 6 Cable Tester
 - 1) Fluke
 - 2) Ideal
 - 3) Softing
 - 4) Viavi
2. Requirements
 - a. The field tester shall be a level III or greater.
 - b. The field tester shall meet the requirements of ANSI/TIA-568.

C. Augmented Category 6 Cable Tester

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.
 - a. Augmented Category 6 Cable Tester

- 1) Fluke
- 2) Ideal
- 3) Softing
- 4) Viavi

2. Requirements

- a. The field tester shall be a level III-E (IIIe) or greater.
- b. The field tester shall meet the requirements of ANSI/TIA-568.

2.3 OPTICAL FIBER TESTING EQUIPMENT

A. OPTICAL TIME DOMAIN REFLECTOMETER (OTDR)

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.
 - a. Optical Time Domain Reflectometer (OTDR)
 - 1) Fluke
 - 2) Ideal
 - 3) Softing
 - 4) Viavi
2. Requirements
 - a. An OTDR shall be used to provide Tier Two testing, which shall provide information regarding attenuation, connector location and insertion loss, splice location and splice loss, and any other power loss events that may have been created during installation.
 - b. The OTDR shall be utilized from both ends of the fiber strand to better isolate any potential problems.
 - c. For unterminated fiber, a “bare fiber adapter” shall be utilized.

B. OPTICAL POWER MEASUREMENT METER

- a. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.
 - 1) Optical Power Measurement Meter
 - a) Fluke

- b) Ideal
- c) Softing
- d) Viavi

2. Requirements

- a. An Optical Loss Test Set (OLTS) shall be used to provide Tier One testing, which shall provide information regarding link attenuation, continuity, and polarity of the installed fiber optic cable.
- b. The OLTS shall be used with the appropriate adapters to allow connectivity to the optical fiber link.
- c. The OLTS shall meet the launch requirements of ANSI/TIA-455-78B.

C. OPTICAL FIBER INSPECTION SCOPE (or FIBER VIEWERS)

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.

a. Optical Fiber Inspection Scope

- 1) AFL
- 2) EXFO
- 3) Fluke
- 4) Softing
- 5) Viavi

2. Requirements

- a. An Optical Fiber Inspection Scope shall be utilized to examine all ends of fiber optic strands prior to splicing or termination.
- b. The Optical Fiber Inspection Scope shall have a minimum of 400x magnification. If the cable and/or connectivity manufacturer requires greater magnification to meet their installation requirements, the more restrictive standard shall apply.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 IDENTIFICATION / LABELING

A. General

1. Labels or tags containing a unique cable ID designator as specified on the drawings or herein shall be placed on both ends of all cables, 6 inches (152.4 mm) from the connector and/or terminal block.
2. Label or tag all cables passing through Telecommunications rooms.
3. Subsequent to placing and terminating cables, place the appropriate cable label.
4. The administration of the Telecommunications infrastructure includes:
 - a. Labels (plates, tags, etc.) to identify individual components.
 - b. Schedules (or other records (printed and/or in computer data base form) to document information about the individual components and the relationships between them.
 - c. Plans or drawings to assist with visualizing the physical and/or logical locations of the components.
5. Provide labels on all applicable items installed under this work and to provide all related records and drawings so that the Owner will be able to administer the Telecommunications infrastructure.

B. Labeling Installation

1. Labels that are to be secured by adhesive shall have a type of adhesive that is appropriate for the particular surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.
2. Labels, plates and tags are to be installed in such a manner that they will be accessible, both physically and visually, after completion of the work. (Exception: It is understood that labels on the outlet end of station cables are generally not visible unless the face plates, bezel, module, etc., is removed or opened.)
3. Any temporary labels used during installation, cable pulling, etc. are to be removed and replaced by the permanent labels identified in Part 2 of this specification before the work will be accepted.
4. If at any time during the job the cable tag becomes illegible or removed for whatever reason during the construction period, immediately replace it with a duplicate pre-printed cable tag at the Contractor's expense before the work will be accepted.

C. Labeling Requirements

1. Labels, plates and tags are to be installed on:
 - a. All Telecommunications rooms (spaces).
 - b. All horizontal links and their components, including:

- 1) Attaching a label no more than 6 inches (152.4 mm) from both ends of all horizontal cables installed under this work.
 - 2) Labeling/Color Coding of cable termination hardware (terminal blocks, outlets, patch panel jacks, etc.) installed under this work.
 - 3) Labeling/Color Coding of major termination assemblies (such as termination fields or frames, racks, etc.) installed under this work.
 - 4) Labeling the Telecommunications outlet housing individual connectors in the work area.
 - a) Labeling each connector terminating horizontal cables in these outlets.
 - b) Label identification within a given space (work area) shall begin at the entrance to the space and proceed in a clockwise manner around the space.
 - 5) Any additional components required by ANSI/TIA-606
- c. All components of the commercial grounding and bonding system for Telecommunications; to include but not limited to all bonding conductors, TMGB and TGB's.
- d. All building backbone cables and their components, including:
- 1) Attaching a label no more than 6 inches (152.4 mm) from both ends of all backbone cables installed under this work.
 - 2) Labeling of backbone cables as they transit through other Telecommunications rooms (spaces)
 - 3) Labeling/Color Coding of cable termination hardware (terminal blocks, outlets, patch panel jacks, etc.) installed under this work.
 - 4) Labeling/Color Coding of major termination assemblies (such as termination fields or frames, racks, etc.) installed under this work
 - 5) Any additional components required by ANSI/TIA-606.
- e. All required fire stopping systems.
- f. All campus backbone cables and their components, including:
- 1) Attaching a label no more than 6 inches (152.4 mm) from both ends of all backbone cables installed under this work.
 - 2) Labeling of backbone cables as they transit through other Telecommunications rooms (spaces)
 - 3) Labeling/Color Coding of cable termination hardware (terminal blocks, outlets, patch panel jacks, etc.) installed under this work.

- 4) Labeling/Color Coding of major termination assemblies (such as termination fields or frames, racks, etc.) installed under this work
- 5) Any additional components required by ANSI/TIA-606.
- g. All pathways (e.g., inner duct, cable racking, conduit, etc.) installed under this work.
 - 1) All interior pathways including cable trays and conduits shall be striped, traced, colored, or marked.
- h. Provision of a database that records appropriate information regarding all cabling, terminations, frames, racks, etc. installed under this work.
- i. In general, the label, plate or tag is to be provided and installed by whoever installed the item that is being labeled.
- j. Refer to individual Telecommunications specification sections (Division 27) and to the Telecommunications drawings for additional information on labeling requirements.

3.3 TEST REPORTS FOR THE STRUCTURED CABLING SYSTEM

A. General cable testing

- 1. Pre-installation testing:
 - a. Visually inspect all cables, cable reels/boxes, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
 - b. Where post-manufacturer test data has been provided by the manufacturer on the reel, box or shipping carton: submit copies to the Owner prior to installing cables.
 - c. Mark reels or boxes as tested/inspected and submit associated test results to Owner/Design Consultant.
 - d. Do not install any cable with less than the manufacturer's guaranteed number of serviceable conductors.
- 2. Post-installation testing:
 - a. Calibrate all testers prior to use in accordance with manufacturers' printed instructions.
 - b. Conduct cable testing as described below upon completion of installation. Test fully completed systems only. Piecemeal testing is not acceptable.
 - c. Remove all defective cables from pathway systems. Do not abandon cables in place.
- 3. All test results and corrective procedures are to be documented and submitted to the Owner within five (5) working days of test completion.

- a. Prior to testing, submit for review and approval copies of test report forms proposed for use.
 - b. Each test report shall contain the following general information: Date of Preparation, Date of Test, Project Name, Contractor's Name, Media Type, Make, Model and Serial Number of test equipment used, Date of Last Calibration and Names of Test Crew.
- B. Copper cable testing
 1. Perform all manufacturer recommended and required test calibration procedures prior to testing any cables.
 2. Paired and multi-conductor riser metallic cables:
 - a. After terminating and splicing the cables. Test all cable pairs for continuity, ground fault, proper cross-connection, shorts and crossed pairs.
 - b. After installing cross-connects, perform end-to-end testing of each cross-connected cable pair for continuity, ground fault, proper cross-connection, shorts and crossed pairs.
 - c. Cable test reports: As a minimum, also provide: cable number, cable type, pair or conductor count, individual pair or conductor numbers, number of cross-connects and/or patches in each pair, results of each test for each pair or conductor, total number of serviceable pairs or conductors in cable.
 3. Four-Pair Cables:
 - a. After terminating both ends of all 4-pair cables, but before any cross-connects are installed, test these cables for the following:
 - 1) Category 3 Cables and high pair count cables (25, 50, 100, 200-pairs, etc.).
 - a) Wire map
 - b) Length
 - c) Insertion loss
 - d) Near-end crosstalk (NEXT) loss
 - e) Propagation delay
 - f) Delay skew
 - 2) Category 6 UTP
 - a) Wire map
 - b) Length
 - c) Insertion loss

- d) Near-end crosstalk (NEXT) loss.
 - e) Power sum near-end crosstalk (PSNEXT)
 - f) Equal-level far-end crosstalk (ELFEXT)
 - g) Power sum equal-level far-end crosstalk (PSELFEXT)
 - h) Return loss
 - i) Propagation delay
 - j) Delay skew
- 3) Augmented Category 6 F/UTP Cables
- a) Wire map
 - b) Length
 - c) Insertion loss
 - d) Near-end crosstalk (NEXT) loss.
 - e) Power sum near-end crosstalk (PSNEXT)
 - f) Equal-level far-end crosstalk (ELFEXT)
 - g) Power sum equal-level far-end crosstalk (PSELFEXT)
 - h) Return loss
 - i) Propagation delay
 - j) Delay skew
 - k) Alien Crosstalk (AXTalk) – Follow manufacturer's instructions for method
4. After installing cross-connects, perform end-to-end testing of each cross-connected cable for continuity, ground fault, proper cross-connection, shorts and crossed pairs. For 100 pair or smaller cables, replace entire cable if bad pair is found. For larger pair-count cables, replace if more than 1% of pairs are bad.
5. Submit the following information regarding the cable testing: cable number, cable type, pair or conductor count, individual pair or conductor numbers, number of cross-connects and/or patches in each pair (if applicable), results of each test for each pair and total number of serviceable pairs in cable.
6. In addition to the tests specified above, provide a minimum of two suitably qualified cabling technicians and copper test equipment to be present on-site for a period of 2 hours during the Design Consultant's Substantial Completion Review. Be prepared to conduct on-the-spot cable

tests as requested. Successful equipment performance tests do not relieve the Contractor from the specified testing, repair, and documentation requirements.

C. Optical Fiber cable testing

1. Post-installation testing:
 - a. After installation of connectors, visually inspect each fiber end-face at 50X magnification. Refinish fibers with visible defects and/or striations in the core area.
 - b. Perform end-to-end, bi-directional attenuation (loss) test for each multimode fiber strand at 850nm and 1300nm. Conduct tests in accordance with TIA-526-14, Method B and with test instrument manufacturer's printed instructions.
 - c. Perform end-to-end, bi-directional attenuation (loss) test for each singlemode fiber strand at 1310 and 1550 wavelengths. Conduct tests in accordance with TIA-526-7, Method A.1 and with test instrument manufacturer's printed instructions.
 - d. Demonstrate that measured link loss does not exceed the "worst case" allowable loss which is defined as the sum of: the connector losses (based on the number of mated connector pairs at the ANSI/TIA-568 maximum allowable loss of 0.75dB per mated pair) and the optical fiber loss (based on length and the ANSI/TIA-568 maximum allowable loss (3.5dB/km @ 850nm and 1.5dB/km @ 1300nm for multi-mode and 1.0dB/km @ 1300 and 1550nm for single-mode) by more than 1.0dB.
 - e. Strands whose measured attenuation fall outside the acceptable range shall be subject to further inspection and testing to determine the nature of the fault. At a minimum, an OTDR shall be used to: determine the true loss for each connector pair, the exact length of the fiber and to identify the presence of any core damage.
 - f. Faults related to fiber being connectorized shall be corrected, and the fiber re-tested as described above, until acceptable attenuation measurements are recorded.
 - g. Where defects are found to be inherent in the fiber itself: replace any cable having fewer than the manufacturer's guaranteed number of serviceable fibers.
 - h. Provide testing in accordance with manufacturer's requirements for a fully-warranted cabling system(s) as required by these Contract Documents.
2. Testing jumpers used shall remain connected at the test equipment for the entire duration of testing. If at any time the jumper becomes loose or removed, for any reason, the jumper shall be reinstalled and re-referenced. This procedure shall be documented each time it is performed to indicate date, time and who performed the procedure. This log shall accompany test reports submitted.
3. All test results and corrective procedures are to be documented and submitted to the Owner within five (5) working days of test completion.
 - a. Prior to testing, submit for review and approval copies of test report forms proposed for use.

- b. Each test report shall contain the following general information: Date of Preparation, Date of Test, Project Name, Contractor's Name, Media Type, Make, Model and Serial Number of test equipment used, Date of Last Calibration and Names of Test Crew.
 - c. Cable number, fiber count, individual fiber numbers, connector types, number of connectors/patches, calculated maximum link loss, length or run, measured link loss for each fiber.
4. In addition to the tests specified above, provide a minimum of two suitably qualified cabling technicians and fiber test equipment to be present on-site for a period of 2 hours during the Design Consultant's Substantial Completion Review. Be prepared to conduct on-the-spot cable tests as requested. Successful equipment performance tests do no relieve the Contractor from the specified testing, repair, and documentation requirements.

D. Acceptance

1. The Owner and Design Consultant reserve the right to observe the conduct of any or all portions of the testing process.
 - a. The Owner and Design Consultant further reserves the right to request the Contractor conduct a random re-test of up to ten percent (10%) of the cable plant to confirm documented test results during the Substantial Completion Review. If more than 5% of these randomly tested cables do not pass, the Owner and Design Consultant reserves the right to require a re-testing of 100% of the cable plant, all without additional costs to the project.
2. For 100 pair or smaller replace entire cable if a bad pair or conductor is found. For larger pair count cables, replace if more than 1% of pairs are bad.
3. All test results are to be documented and submitted to the Architect in a timely manner, in accordance with the Submittal instructions in Part 1 of this section.
 - a. Corrective procedures following the Substantial Completion Review shall be properly documented, and affected and new cables shall be retested prior to Substantial Completion.
 - b. Updated complete Test Results, including retested, new and unaffected cables, shall be included in the Final Project Completion submittal.

3.4 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:
1. The complete build-out of all Communications Rooms, cleaned of dust and debris.
 2. Installation, termination, final labeling, and testing of all backbone and horizontal cabling.
 3. The installation and labeling of all firestopping systems required for Telecommunications cabling and outlets. If firestopping was provided by a separate contractor (per Division 27 "Common Work Results for Communications"), ensure all firestopping systems are installed and labeled.

4. The installation, labeling, and testing of the Telecommunications Grounding and Bonding System.
5. Ensure faceplates are level, free of dust and paint, match color/style of adjacent electrical receptacle, and have blue protective film removed.
6. Update jobsite Work Prints with all individual port / cable IDs, which shall correspond to the cable IDs in the Test Results.
 - a. These shall then be scanned to PDF (minimum resolution of 150 dpi) to be included in the Preliminary Project Completion documentation outlined in the Part 1 Submittal requirements earlier in this section.
- B. Request in writing a review for Substantial Completion. Refer to Part 1 Submittal requirements earlier in this section for required notice and Preliminary Project Completion documentation that shall be included with this request.
- C. State in the written request that the Contractor has complied with the requirements for Substantial Completion for the (Telecommunications) Structured Cabling System.
- D. Upon receipt of a request for review, the Architect will either proceed with the review or advise the Contractor of unfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Architect and Design Consultant for time and expenses incurred for the visit.
- F. Upon completion of the review, the Architect and Design Consultant will prepare a “final list” of outstanding items to be completed or corrected for final acceptance. Omissions on the “final list” shall not relieve the Contractor from the requirements of the Contract Documents.

3.5 SPECIAL TOOLS

- A. Delivery to Owner's representative 2 complete sets (UON) of all special tools and small equipment items needed for proper operation, adjustment and maintenance of cabling and equipment installed under this work. All tools to be new and still in manufacturers packaging. The cost for these tools is to be included within the bid price for this work.
- B. The terms “special tools” and “small equipment items” is meant to include such items as punch down tools, connector assembly tools, etc. with each individual item having a retail replacement cost not exceeding five hundred dollars (\$500.00). It is NOT meant to include common hand tools such as standard screwdrivers, pliers, wrenches, etc.

END OF SECTION 271000

SECTION 271100 - TELECOMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. Section includes fittings that are within the physical walls of the communications equipment rooms to support the Telecommunications System. Fittings include but are not limited to:
 - 1. Grounding & Bonding
 - 2. Plywood Backboard
 - 3. Entrance Protection
 - 4. Cabinets, Racks, Frames, and Enclosures
 - 5. Fiber Media Converter
 - 6. Termination Blocks and Patch Panels
 - 7. Cable Management and Ladder Rack
- B. Section does not specify fittings such as cables, cable terminations, termination blocks, and patch panels for structured cable system (SCS). These components are specified in the Division 27 Section "Communications Backbone Cabling" and Division 27 Section "Communications Horizontal Cabling".

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

- A. Follow all applicable codes, references, and standards listed in Division 27 Sections "General Communications Requirements" and "Structured Cabling System".
- B. Division 26 Section "Grounding and Bonding for Electrical Systems".

1.3 DEFINITIONS

- A. Communications Equipment Room – This CSI MasterFormat™ term shall apply to spaces specifically designed to maintain communications equipment. This definition shall encompass ANSI/TIA-569 terms for Entrance Room, Common Equipment Room (CER), and Common Telecommunications Room (CTR). This definition also shall encompass BICSI Telecommunications Distribution Methods Manual terms for Telecommunications Room (TR), Telecommunications Enclosure (TE), Equipment Room (ER), and Entrance Facility (EF).
- B. Communications Entrance Protection – Fittings that reduce risk to life, limb, or property by protecting against power surges. This definition shall encompass protection devices and fittings described in Article

770 “Optical Fiber Cables and Raceways” and Article 800 “Communications Circuits” of NFPA 70 “National Electrical Code”.

- C. Communications Cabinet – A floor or wall mount unit enclosed with side panels. Communications equipment is supported by mounting rails separated at 19” or 23” inches.
- D. Communications Rack – A floor or wall mount unit without side panels. Racks can be 2-post or 4-post. Communications equipment is supported by mounting rails separated at 19” or 23” inches.
- E. Communications Frame - A floor or wall mount unit without side panels. Communications termination blocks are the only communications devices mounted to the unit.
- F. Communications Enclosure – A floor or wall mount unit enclosed with side panels. Communications equipment is not supported by mounting rails separated by 19” or 23” inches. This definition shall encompass BICSI Telecommunications Distribution Methods Manual term for Telecommunications Enclosure (TE).
- G. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.
- H. Grounding Equilizer (GE) – The conductor that interconnects elements of the telecommunications grounding infrastructure.
- I. Telecommunications Bonding Backbone (TBB) – A conductor that interconnects the telecommunications main grounding busbar (TMGB) to the telecommunications grounding busbar.
- J. Telecommunications Main Grounding Busbar (TMGB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

1.4 SUBMITTALS

- A. Follow the requirements for submittals in Division 27 Sections “General Communications Requirements” and “Structured Cabling System”.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of device from a single manufacturer and through one source. Where practical and possible, obtain all devices from a single manufacturer and one source.
- B. Communications equipment room fittings shall be listed by a NRTL.

PART 2 - PARTS AND MATERIALS

2.1 ANSI/TIA-607-COMPLIANT TELECOMMUNICATIONS GROUNDING AND BONDING SYSTEM

A. General

1. Provide a complete functioning telecommunications grounding and bonding system, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary for the system to be in compliance with the ANSI/TIA-607 Standard "Generic Telecommunications Bonding and Grounding for Customer Premises". Major components include:
 - a. TMGB in the Main Telecommunications Room and TGBs in all remaining Telecommunication Rooms and Spaces.
 - b. BCT connecting the TMGB to the main Electrical Service Ground.
 - c. TBB connecting the TMGB to all TGBs.
 - d. All equipment and pathway grounding and bonding connections as identified on the drawings, recommended by manufacturers of equipment installed under this section, and stipulated in the referenced standard.
2. Component Manufacturers:
 - a. Chatsworth
 - b. Cooper B-Line
 - c. Erico
 - d. Harger
 - e. Hoffman
 - f. Panduit
3. Conductor Manufacturers
 - a. Shall be from the list of Component Manufacturers; or
 - b. Shall be from the list of Manufacturers in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".

B. Telecommunications Main Ground Bar (TMGB)

1. Specifications
 - a. All busbars shall have a clear cover installed to protect connections

- b. Cover shall be:
 - 1) Plexiglass or plastic
 - 2) Cover shall be printed with 3/8" lettering "TMGB" (or "TGB") using appropriate labels.
 - 3) Of the same manufacturer as the ground bar
 - c. A predrilled Electrotin plated copper busbar provided with holes for use with standard sized lugs; hole patterns shall be in TIA/BICSI style.
 - d. Have minimum dimensions of 1/4 inch thick x 4 inches wide x 20 inches long.
 - e. Provide enough length for all connections with 25% growth.
 - f. Provided with insulators to electrically isolate busbar from mounting surface.
 - g. Provided with a minimum of 2-inches clearance from wall or other mounting surfaces for access.
2. Manufacturer shall be
- a. Harger TGBIP14420TMGB
 - b. Chatsworth 40153-020
 - c. Or equivalent from Component Manufacturer

C. Telecommunications Ground Bar (TGB)

1. Specifications

- a. Be a predrilled Electrolytically plated copper busbar provided with holes for use with standard sized lugs
- b. Have minimum dimensions of 1/4 inch thick x 2 inches wide x 12 inches long
- c. Provided with insulators to electrically isolate busbar from mounting surface
- d. Provided with a minimum of 2-inches clearance from wall or other mounting surfaces for access.

2. Manufacturer shall be

- a. Harger TGBI14212TGB
- b. Chatsworth # 13622-012
- c. Or equivalent from Component Manufacturer

D. Ground Wire for TBB

1. Specifications

- a. All grounding and bonding connectors shall be listed by a Nationally Recognized Testing Laboratory (NRTL) as required by the NEC.
- b. All grounding and bonding conductors shall be copper and may be insulated UON. When conductors are insulated, they shall be listed for the application (i.e. Plenum, riser, outside plant, etc.)
- c. Ground Wire for TBB: Non-Insulated grounding wire with a minimum conductor size as indicated on drawings. Wire shall be UL listed.
- d. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name.
 - 2) Copper Conductor Gauge.
 - 3) UL listing.
- e. Cable jacket shall be green with black lettering.
- f. Sizing shall be per Part 3 of this section. All sections of TBB longer than 300 feet shall be 750 kcmil.

- E. Bonding Conductor (To main Electrical service ground) for Telecommunications (BCT): Insulated grounding wire with a minimum copper conductor size equal to that of the TBB, with PVC insulation. Shall be UL listed.

1. Specifications

- a. Shall be copper.
- b. Insulated grounding wire with PVC insulation
- c. A minimum copper conductor size equal to that of the largest TBB or other bonding conductor connected to the TMGB, UON.
- d. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name
 - 2) Copper Conductor Gauge
 - 3) NRTL listing information
- e. Cable jacket shall be green with black lettering
- f. A minimum conductor size as indicated on drawings

- F. Ground Wire (for connections within each Telecommunications Room and to Cable Tray)

1. Specifications

- a. Shall be copper.
- b. When not routed through plenum or other air-handling space: Insulated grounding wire with a minimum copper conductor size of number 6 AWG, with PVC insulation. Shall be UL listed.
- c. When routed through plenum or other air-handling space: Non-Insulated grounding wire with a minimum copper conductor size of number 6 AWG. Shall be UL listed.
- d. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name.
 - 2) Copper Conductor Gauge.
 - 3) UL listing.
- e. Cable jacket shall be green with black lettering.

- G. Connectors / Connections

1. Specifications

- a. All connectors and connections shall utilize products that are Listed by a NRTL such as UL.
 - b. All connectors shall have twin clamping elements for cable; two holes for attachment to grounding bar, etc.
2. Compression Lugs
- a. Specifications
 - 1) Shall be manufactured from electro-plated tinned copper for use with copper conductors.
 - 2) Shall include inspection port.
 - 3) On center dimension between holes (O.C. Dim. B/T Holes) shall be 0.625" ("A" Pattern) or 1" ("C" Pattern)

- b. Manufacturer shall be:
 - 1) Harger GECLB Series
 - 2) Or Approved Equivalent
- 3. Conductor to conductor connection
 - a. Specifications
 - 1) All connections between conductor and the joining or mating of cables to connectors shall be done by exothermic weld or irreversible compression connector.
 - b. Manufacturer – Exothermic Weld
 - 1) Erico CADWELD
 - 2) Harger Ultraweld
 - 3) Or Approved Equivalent
 - c. Manufacturer – Irreversible Compression connector
 - 1) Burndy HYGROUND
 - 2) Or Approved Equivalent
- 4. Connector for conduit to cable
 - a. Specifications
 - 1) All continuous conduits (except entrance conduits) which extend into the Telecommunications Room shall be fitted with a pipe clamp or conduit bonding clamp connected to the TMGB/TGB.
 - b. Manufacturer shall be:
 - 1) For 1” diameter and larger conduits – Harger series CPC electro tin-plated pipe clamp
 - 2) For less than 1” diameter conduits – Harger TBGC4SCS electro tin-plated conduit bonding clamps
 - 3) Or Approved Equivalent
- 5. Connector for conductor to cable tray
 - a. Specifications
 - 1) For metallic cable trays that extend to the Telecommunications Room.
 - b. Manufacturer shall be:

- 1) Harger electro tin-plated cable tray bonding clamps – TBCTC
- 2) Or Approved Equivalent

H. Insulated Grounding Bushings

1. Specifications

- a. All communications entrance conduits that extend into the Telecommunications Room shall be fitted with an Insulated Grounding Bushing.
- b. Shall be UL Listed for copper conductors.
- c. Shall include lug for easy connection of conductor to TMGB/TGB.

2. Manufacturer shall be:

- a. O-Z/Gedney IBC-L
- b. Or Approved Equivalent

2.2 PLYWOOD BACKBOARD

- A. 4' x 8' sheets of 3/4" thick (minimum) fire-retardant plywood.

2.3 TELECOMMUNICATIONS ENTRANCE PROTECTION

A. Surge Protection

1. The following manufacturers are Conditionally Approved:

- a. Circa Telecom
- b. Emerson Network Power
- c. ITWLinx
- d. TII Network Technologies
- e. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

2. Building Entrance Terminals (Primary Protectors) – for multi-pair (25+ pairs) Outside Plant Category 3 Copper Backbone Cabling that are fed from outside the footprint of the building.

a. Requirements

- 1) Consist of an arrester connected between each line conductor and ground, a fuse in series with each line conductor, in an appropriate mounting arrangement.

- 2) 110 Insulation Displacement Contact (IDC) connector input and output.
- 3) Wall mountable.
- 4) Vertically stackable.
- 5) Shall have external ground lug for building ground or connecting additional units.
- b. Product shall be
 - 1) ITWLinx UltraLinx
 - 2) Or equivalent from list of Conditionally Approved manufacturers above
3. Horizontal Cable Surge Protectors – for 4-pair, Category 5e/6 horizontal cables that serve outlets exterior the footprint of the building, including, but not limited to, cables serving outlets that are mounted on roofs, exterior walls, light poles, and emergency phones/towers.
 - a. Requirements
 - 1) Shall meet UL 497
 - 2) Shall exceed TIA 568 Category 6 performance standards
 - 3) Shall be capable of being used with POE+ applications
 - b. Wall-mount Protectors – for single cables, where quantity of cables in Equipment Room needing protection is 6 or less
 - 1) Manufacturer shall be:
 - a) Emerson Edco CAT6-POE
 - b) ITWLinx SurgeGate Series CAT6-LAN
 - c. Rack-mount Protectors – where more than 6 cables in an Equipment Room require surge protection
 - 1) Shall be rack-mountable in 19" wide equipment rack
 - 2) Provide quantity of Category 6 protectors/modules required for install, plus 25% spare
 - 3) Manufacturer shall be:
 - a) APC ProtectNet Chassis (PRM24) with Cat 6 Surge Modules (PNETR6)
 - b) Emerson Edco RM-CAT6-**POE
 - d. Far-end Protection: Wherever connected devices (such as cameras) do not have integral protection, provide the following at the far-end of the cable:

- 1) Blackbox CAT6 In-Line Surge Protector
- 2) Emerson CAT6-5POE-FF

2.4 TELECOMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

A. Two-Post Floor Rack

1. The following manufacturers are Conditionally Approved:

- a. APC
- b. B-Line
- c. Chatsworth Products
- d. Great Lakes
- e. Hoffman
- f. Middle Atlantic
- g. Ortronics
- h. Panduit
- i. Or connectivity manufacturer carrying structured cabling warranty
- j. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)

2. Requirements

- a. Approximately 7'-0" in height with 45U available to mount panels/equipment.
- b. Mounting rails shall be spaced 19" wide per ECA EIA/ECA-310-E. Mounting rails shall contain #12-24 tapped holes for patch panel applications. Mounting rails shall contain front and rear flange mounting holes for panels/equipment.
- c. Two-post rack shall be minimum 14 gauge carbon steel construction and have a self-supporting base.
- d. Finish shall be either powder coat in black. Provide touch-up paint matching powder coat.
- e. Minimum static load capacity: 1,000 lb
- f. UL Listed
- g. Secure rack to floor. Provide rack manufacturer's rack installation kit matching floor type of rack installation for a complete system meeting drawings and manufacturer instructions.

Raised floor racks shall be mounted to sub or base floor with 5/8" threaded rods and steel brackets.

- h. Provide 6" stand-off bracket accessory on top of rack to mount ladder rack.
- i. Provide free standing relay rack accessories such as rack base insulator kit, rack line-up spacer kit, rack base dust cover, equipment support bracket, equipment guard rail, and RMU Label Kit for a complete system meeting drawings and manufacturer instructions.

B. Four-Post Floor Rack

- 1. The following manufacturers are Conditionally Approved:
 - a. APC
 - b. B-Line
 - c. Chatsworth Products
 - d. Great Lakes
 - e. Hoffman
 - f. Middle Atlantic
 - g. Ortronics
 - h. Panduit
 - i. Or connectivity manufacturer carrying structured cabling warranty
 - j. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)
- 2. Requirements
 - a. Approximately 7'-0" in height with 45U available to mount panels/equipment.
 - b. Mounting rails shall be spaced 19" wide per ECA EIA/ECA-310-E. Mounting rails shall contain #12-24 tapped holes for patch panel applications. Mounting rails shall contain front and rear flange mounting holes for panels/equipment.
 - c. Four-post rack shall be minimum 14 gauge carbon steel construction and have a self-supporting base.
 - d. Finish shall be powder coated in black. Provide touch-up paint matching powder coat.
 - e. Minimum static load capacity: 1,500 lb.
 - f. UL Listed

- g. Secure rack to floor. Provide rack manufacturer's rack installation kit matching floor type of rack installation for a complete system meeting drawings and manufacturer instructions. Raised floor racks shall be mounted to sub or base floor with 5/8" threaded rods and steel brackets.
 - h. Provide free standing relay rack accessories such as rack base insulator kit, rack line-up spacers, dolly wheels, equipment support bracket, equipment guard rail, and RMU Label Kit for a complete system meeting drawings and manufacturer instructions.
 - 3. Product shall be
 - a. Chatsworth 1521(*)-(***)
 - b. Or equivalent from list of Conditionally Approved manufacturers above
- C. Fixed Wall Rack
- 1. The following manufacturers are Conditionally Approved:
 - a. APC
 - b. B-Line
 - c. Chatsworth Products
 - d. Great Lakes
 - e. Hoffman
 - f. Middle Atlantic
 - g. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)
 - 2. Requirements
 - a. Approximately 2'-0" in height with 13U available to mount panels/equipment.
 - b. Mounting rails shall be spaced 19" wide per ECA EIA/ECA-310-E. Mounting rails shall contain #12-24 tapped holes for patch panel applications. Mounting rails shall contain front and rear flange mounting holes for panels/equipment.
 - c. Fixed wall rack shall be [aluminum construction] [minimum 14 gauge carbon steel construction] and have a self-supporting base.
 - d. Finish shall be powder coat in black. Provide touch-up paint matching powder coat.
 - e. Minimum static load capacity: 200 lb.
 - f. UL Listed.

- g. Secure rack to wall. Install rack per manufacturer's hardware requirements and installation instructions for wall type.
 - h. Provide free standing relay rack accessories for a complete system meeting drawings and manufacturer instructions.
 - i. Fixed wall rack depth shall be 18".
- 3. Product shall be
 - a. Chatsworth 11960-718
 - b. Or equivalent from list of Conditionally Approved manufacturers above

2.5 TELECOMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

A. General

- 1. All telecommunications termination blocks and patch panels shall be by the same manufacturer and covered under the same Advanced Structured Cabling System Warranty.
 - a. Refer to Advanced System Warranty sub-section of Division 27 "Structured Cabling System" for list of approved connectivity manufacturers

B. Wall-mount Termination Blocks - Copper

- 1. Terminal blocks shall be provided complete with all mounting hardware, connecting blocks, retainers, wire guides, designation strips, etc.
- 2. Connecting Blocks: shall be 110-Style IDC Wiring Block for backbone cabling. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector blocks, including plugs and jacks where indicated.
 - a. The wiring blocks specified for backbone cabling shall support Category 3 applications and facilitate cross connection and interconnection using either cross connect wire (voice only) or the appropriate category patch cords.
 - b. The wiring block shall accommodate 22- through 26-AWG conductors and shall be able to mount directly on wall surfaces.
 - c. Clear label holders with the appropriate colored inserts shall be provided with the wiring blocks. The insert labels shall contain vertical lines space on the basis of circuit size to be cross-connected (3, 4, or 5-pair) and shall not interfere with running, tracing or removing jumper wire/patch cords.
 - d. The wiring blocks shall be available in 100 and 300 pair sizes. UON all wiring blocks shall be installed with legs.

- e. Provide the appropriately sized blocks without legs only when depth restrictive situations are encountered. As approved by the Engineer/Owner (i.e. Where clearance spaces would be inadequate if installed with legs)
 3. Submit Manufacturer and part number as part of pre-construction submittals.
- C. Rack-mount Modular - Copper Patch Panels
 1. General Requirements for Patch Panels: Comply with referenced standards. Cables shall be terminated with connecting hardware of same category or higher.
 2. Patch panels shall be provided complete with all mounting hardware, jacks, retainers, wire guides, designation strips, etc.
 3. Patch panels shall accept modular jacks of exactly one port, and this modular jack shall be the same type as being installed at the far-end faceplates.
 4. Provide enough ports for the number of cables terminated on the patch panel, plus 25 percent spare. Provide all connector blocks', including plugs and jacks where required to fill each panel completely. Do not leave any blank openings.
 5. Modular Patch Panels shall be of a metal design with snap in module frames for each individual jack.
 6. Ports and panels shall be easy to identify with label holders for machine-printed and color-coded labels. Rack mountable patch panels shall mount to standard EIA 19" racks.
 7. Horizontal Cabling
 - a. Four-pair Category 6 UTP cabling shall be terminated onto a four-pair Category 6 jack module. All jack modules shall be terminated using the T568B wiring scheme. The eight-position jack module shall exceed the connector requirements of the TIA Category 6 standard.
 - b. Four-pair Augmented Category 6 UTP cabling shall be terminated onto a four-pair Augmented Category 6 jack module. All jack modules shall be terminated using the T568B wiring scheme. The eight-position jack module shall exceed the connector requirements of the TIA Augmented Category 6 standard.
 8. Submit Manufacturer and part number as part of pre-construction submittals.
- D. Rack-mount Optical Fiber Panels
 1. Fully enclosed cable management type patch panel. Rack mountable in equipment cabinets/racks. Front and rear access (front access only for wall mounted). Complete with all necessary cable clamps, couplings and connector bulkheads.
 - a. Optical fiber cables shall be terminated in cable management trays/modules.

- b. Cable management module/tray can accommodate optical fiber patch cable. Tray/module shall provide a means to avoid exceeding the cable manufacturer's minimum bending radius to protect against crimping or over bending.
 - c. Cable management tray shall have labeling on the front of the tray.
 - d. Optical fiber patch panels shall have a plexiglass latching front panel. Labeling and connectors shall be clearly visible with front panel open or closed.
 - e. Optical fiber patch panels shall accept a variety of inter-changeable bulkheads including ST, SC, LC, FDDI as well as attenuators.
 - f. Optical fiber patch panels shall provide a splice tray option.
2. Optical fiber termination method(s)
- a. Factory-terminated pigtail and with fusion splice
 - b. Multi-mode connectors:
 - 1) Simplex multimode LC connectors and adapters. Color shall be beige. Suitable for use with specified multi-mode optical fiber. Maximum insertion loss across mated pair: less than 0.75dB.
3. Submit Manufacturer and part number as part of pre-construction submittals.

1.1 FIBER MEDIA CONVERTER

A. General

- 1. To be utilized where noted on drawings and for any telecommunications devices that requires a Category 6A connection, where the cable distance exceeds 295 feet.

B. Fiber Media Converter

- 1. Media converter to convert fiber optic cable into PoE Category 6A connection.
- 2. Media converter shall get 120V power from adjacent receptacle.

C. Product shall be:

- 1. Omnitron Systems OmniConverter Managed 10 port PoE Gb Ethernet switch
- 2. Or Approved Equal

2.6 TELECOMMUNICATIONS PATCH CABLES & CROSS-CONNECT WIRES

A. General

1. Supply all necessary patch cables and cross-connect wires as part of a complete and functioning telecommunications system to support voice, data, audio-video, security, and other miscellaneous systems.
2. The manufacturer of patch cables shall be the same as the telecommunications connectivity, unless otherwise specified.
3. All patch cables shall be factory-terminated and tested.

B. Copper Cross-Connect Wires

1. Provide cross-connect wires as indicated on the drawings and as required to form a complete and functioning telecommunications system. This includes extension of analog voice lines from the service provider demarcation point to the following connections:
 - a. Fire Alarm Control Panels
 - b. Elevator phones
 - c. Fax machines – assume at least one fax machine location on the project; coordinate final location(s) with Owner during construction
2. Manufacturer shall be:
 - a. Same as copper connectivity or backbone cabling manufacturer
 - b. Submit product cutsheet for review

C. Fiber Optic Patch Cords

1. Multimode
 - a. Multimode type shall match that of fiber backbone cabling/adapters (OM3/4) and terminations
 - b. Connectors shall be LC on both ends.
 - c. Furnish patch cords to the Owner prior to substantial completion in the following lengths and quantities:
 - 1) Total quantity shall be 100% of the terminated ports, in the following lengths:
 - a) All shall be 7'

- d. Manufacturer shall be:
 - 1) Same as fiber connectivity manufacturer
 - 2) Submit product cutsheet for review

2.7 TELECOMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

A. Ladder Rack (Cable Runway)

- 1. Color: black
- 2. Rung Spacing: 9"
- 3. Width: 18"
- 4. UL Listed as an equipment grounding conductor
- 5. Provide ladder rack components such as e-bend, outside radius bend, and corner bracket for a complete system meeting drawings and manufacturer instructions.
- 6. Provide ladder rack supports such as wall angle support kit, triangular support bracket, center support kit, threaded rod, I-beam clamp, threaded ceiling kit, cabinet elevation kit, foot kit, rack mounting plate, rack elevation kit for a complete system meeting drawings and manufacturer instructions.
- 7. Provide ladder rack accessories such as cross member radius drop, end caps, and dividers for a complete system meeting drawings and manufacturer instructions.
- 8. The following manufacturers are Conditionally Approved:
 - a. B-Line
 - b. Chatsworth Products
 - c. nVent/Hoffman
 - d. Middle Atlantic
 - e. Or connectivity manufacturer carrying structured cabling warranty
 - f. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

B. Vertical Cable Managers

- 1. Manufacturer shall be the same as equipment racks and cabinets, unless otherwise noted.
- 2. Color: black
- 3. Size: as specified on drawings, or a minimum of 6" wide by 6" deep, whichever is greater.

4. The following manufacturers are Conditionally Approved:
 - a. B-Line
 - b. Chatsworth Products
 - c. Ortronics
 - d. Panduit
 - e. Or connectivity manufacturer carrying structured cabling warranty
 - f. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)

C. Horizontal Cable Management

1. Manufacturer shall be the same as copper connectivity manufacturer.
2. Color: black
3. Size: 1RU or 2RU, as shown on the drawings.
4. The following manufacturers are Conditionally Approved:
 - a. Belden
 - b. Hubbell
 - c. Leviton
 - d. Ortronics
 - e. Panduit
 - f. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 GROUNDING AND BONDING INSTALLATION

A. General:

1. Install all other ground conductors (wire) without splices or mechanical couplers installed between the wire points of origin and termination except as shown on the Drawings and/or

specified herein. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located in Telecommunications rooms (spaces). Joined segments of a TBB shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage. "Daisy chaining" of Telecommunications ground bus bars back to the TMGB will not be accepted unless specifically indicated on the Telecommunications drawings or specified herein

2. Unless otherwise noted, all ground wires shall be routed through the Telecommunications cable management pathways so as to achieve a "coupled bonding conductor" effect
3. Where insulated conductors are necessary provide adequately rated insulation jackets or pathways to meet all required building codes. (I.e. Plenum, riser, outside plant, run entirely in conduit, etc.)
4. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3 feet (1 meter) in length, the conductors shall be bonded to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum.
5. The Bonding Conductor for Telecommunications (BCT), each Telecommunications bonding backbone (TBB) conductor, and each grounding equalizer (GE), shall be green or marked with a distinctive green color
 - a. Marking with a distinctive green color Shall be done at a minimum of every 1 foot (0.3 meter) by appropriate methods
 - b. Indicate proposed and actual routing of these conductors on overall floor plans in both the pre-construction Shop Drawings and Record Drawings, respectively.
6. Follow additional installation requirements from NECA/BICSI 607-2011 "Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings".

B. Required Grounding Connections:

1. Provide and install one individual ground wire from each equipment rack/cabinet/frame (installed under this work) to the TGB in the room. Each conductor is to be "home run"; do not "daisy chain" the connections, except as may be indicated on the drawings.
2. Provide and install one individual ground wire from the raised floor system (if applicable) to the TMGB. Conductor is to be "home run"; do not "daisy chain" the connections, except as may be indicated on the drawings.
3. Provide and install one individual ground wire from the overhead and vertical ladder racking (installed under this work) to the TGB in the room. All sections of ladder rack shall be securely connected together; otherwise, provide ground wire from each section of ladder rack.
4. Where structural steel is available for connection install one individual ground wire to the nearest structural steel for connection.
5. Provide and install all grounding connections as required by Telecommunications set of drawings.

C. Connector Installation:

1. Provide all ground wire connectors as shown on the Drawings or as indicated herein, unless otherwise noted.
2. Follow the connector manufacturer's instructions for installing the connector to the cable and the connector to the cabinet/rack, ground bar, etc. Use the appropriate tools for the job, tighten nuts/bolts to proper torque, remove paint, insulation, oxidation as needed to assure good metal to metal contact, etc. If the manufacturer does not provide tightening specifications, follow the recommendations of UL Standard 486.

D. Cable Identification:

1. Label both ends of each ground conductor within 6 inches (152.4 mm) of a connector terminal or splice. Label the grounding conductors as shown on the Drawings or specified herein. All labels shall include the following information for each conductor.

**IF THIS CONNECTOR OR CABLE IS
LOOSE OR MUST BE REMOVED,
PLEASE CALL THE BUILDING
TELECOMMUNICATIONS
MANAGER**

E. Quantities of Ground Wires (Conductors)

1. Location and placement of grounding and bonding wires and components shall be as shown on the Drawings or defined herein.
2. Quantities of ground wires, bonding components, etc. shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of materials to construct a grounding and bonding system that meets the intent of these Specifications and the relevant codes.

F. Sizing of Ground Wires (Conductors)

1. Subject to the applicable electrical code and the reference standards and guidelines, the BCT, TBB, GE conductors (if applicable), and conductors to serving electrical panels and building steel shall be sized per the following table (Table 1 from ANSI/TIA-607):

Linear Length (ft)	AWG Size
less than 13	6
14-20	4
21-26	3
27-33	2
34-41	1
42-52	1/0
53-66	2/0
67-84	3/0
85-105	4/0
106-125	250 kcmil
126-150	300 kcmil
151-175	350 kcmil
176-250	500 kcmil
251-300	600 kcmil
Greater than 301	750 kcmil

G. Testing

1. As a minimum test, as described below, all metallic wires and cables installed under these Specifications.
2. Test the grounding conductor and the terminal connectors for total resistance between the equipment item being grounded and the main telecommunications grounding point in the room. This resistance Shall be less than 0.10 Ohm.
3. Recommended test equipment (obtain approval of Owner/ Design Consultant prior to using substitute test equipment):
 - a. An ohmmeter capable of indicating resistance down to 10 milli-ohms or below.

H. Acceptance

1. Upon receipt of the Contractor's documentation of cable testing, the Owner/ Design Consultant will review/observe the installation and randomly request tests of the cables/wires installed. Once the testing has been completed and the Owner/ Design Consultant is satisfied that all work is in accordance with the Contract Documents, the Owner will notify the Contractor in writing.

I. Record Drawings

1. The Project Record Drawings shall show the types and locations of installed grounding and bonding conductors.

3.3 TELECOMMUNICATIONS ENTRANCE PROTECTION INSTALLATION

- A. Fully protect each end of all incoming conductors which are considered to have lightning exposure in accordance with NEC chapter 8.
 - 1. Exception: Service providers will provide and install primary protectors on service entrance cabling.
- B. Install grounding wire as straight as possible from terminal to Grounding Bar.
- C. UON, mount all protection devices on wall surface in a manner sufficient to support the weight, and to sustain incidental contact.
- D. Protector housings shall stack vertically.
- E. Grounding and Bonding of Entrance Conduits
 - 1. Bond all metallic shields and armored jacketing material for all incoming cables as close as practicable to the entry into the building.
 - 2. Bonding conductors shall be connected to the appropriate bus bars as specified in this Section and in accordance with NEC chapter 8.
 - 3. Connect the grounding conductor from the protection devices directly to the TMGB/TGB as specified in this Section and in accordance with the NEC and the manufacturers' recommendations.
 - 4. Verify grounding means exist at each end of the circuit as required by the NEC. If no grounding means exists then provide all connections required by the NEC.

3.4 TELECOMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES INSTALLATION

- A. Wall cabinets, racks, frames, and enclosures shall be installed on a plywood backboard or attached to a masonry wall. The rack should not be attached to sheet rock (gypsum wall board).
- B. Tags/labels shall be placed on each equipment rack, cabinet and frame in accordance with specification Division 27 Section ““Common Work Results for Communications”

3.5 CABLE LADDER RACKING

- A. Installation and configuration shall conform to the requirements of the ANSI/TIA Standards 568C & 569, NFPA 70 (National Electrical Code), NEMA VE2, and applicable local codes.
- B. Install cable ladder racking level and plumb according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.
- C. Install cable ladder racking where indicated in the drawings and as required by these Specifications

- D. Corner clamp brackets shall be used to join sections of cable ladder rack that are perpendicular to each other.
- E. Cable ladder rack stringers shall be attached to plywood backboards with angle brackets and “J” bolts.
- F. End supports and stringer junction brackets shall be used to attach vertical cable ladder segments to the floor.
- G. Stringer junction brackets shall be used to attach end to end horizontal cable ladder rack segments.
- H. Open ended stringer segments shall be closed with corner clamps and end bars.
- I. Mounting plates and “J” bolts shall be used to attach the cable ladder racking to the relay racks or equipment cabinets.
- J. Runway should be supported every 5 feet on center with 1/2 inch diameter threaded rod with slotted hanger clamps, or applicable support brackets or attachments. All wall brackets shall be attached to plywood backboard.
- K. A support shall also be placed within 24 in. on each side of any connection to a fitting.

3.6 CABLE MANAGEMENT AT EQUIPMENT RACKS AND CABINETS

- A. Install cable organizers and/or cable channel on equipment racks and within cabinets at locations as described in the Specifications and/or indicated on the Drawings.

3.7 QUANTITIES OF RACK/CABINET AND DISTRIBUTION FRAME EQUIPMENT AND COMPONENTS

- A. Location and placement of communications equipment room fittings shall be as shown on the Drawings or defined in these specifications and schedules.
- B. Quantities and sizes of communications equipment room fittings shown on the Drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of all materials necessary to accommodate the work described in these specifications and schedules and shown on the Drawings.

- C. Equipment racks, cabinets and distribution frames shall be assembled and installed as per the manufacturers' printed instructions.

END OF SECTION 271100

SECTION 271300 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. Provide a complete intra-building (premises) backbone cabling system in accordance with these Contract Documents. Including but not limited to, the following:
 - 1. Copper UTP Cables
 - 2. Optical Fiber Cables
 - 3. Splices (where required by these Contract Documents)
 - 4. Necessary installation and supporting hardware.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions, requirements, and recommendations in Division 27 Section “General Communications Requirements”
- B. Division 27 “Common Work Results for Communications”
- C. Division 27 “Structured Cabling System”
- D. Division 27 Section “Telecommunications Equipment Room Fittings”

1.3 BACKBONE CABLING DESCRIPTION

- A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.4 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in ANSI/TIA-568, when tested according to test procedures of this standard.

1.5 CODES, REFERENCES, AND STANDARDS

- A. Follow all applicable codes, references, and standards listed in Division 27 Sections “General Communications Requirements” and “Structured Cabling System”.

1.6 GUIDELINES

- A. Follow all applicable guidelines listed in Division 27 Sections “General Communications Requirements” and “Structured Cabling System”.

1.7 QUALITY ASSURANCE

- A. Refer to Division 27 Section “Structured Cabling System” for Quality Assurance requirements.

1.8 SUBMITTALS

- A. Follow the requirements for submittals in Division 27 Section “General Communications Requirements”, as well as the detailed Submittal requirements in Section “Structured Cabling System”. The following additional items shall be submitted:

- B. Pre-Bid Phase:

- 1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Engineer. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.

- C. “Pre-construction” phase:

- 1. Shop Drawings:

- a. Submit for review scaled layout drawings showing the routing of all backbone cabling, with pair/strand counts, cable types, type of pathway (cable tray, j-hooks, conduit, firestopping device) and proposed cable identifiers indicated for each cable. Ideally, this information would be indicated on scaled overall plans for each floor; however, it is permissible to combine with other Structured Cabling System shop drawings for individual areas.
 - 2. Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters).
 - 3. Submit manufacturers’ cut sheets or catalog cut sheets for:
 - a. Each of the cables specified:

- 1) Cut sheets shall include the following information at a minimum:

- a) Manufacturers name and logo
- b) Cable outside diameter
- c) Number of conductors/strands in each cable and binder group
- d) Gauge or strand thickness
- e) Minimum transmission performance rating
- f) Cable jacket material and rating
- g) Maximum pulling tension
- h) Jacket/Sheath color
- i) Individual conductor or strand insulation colors
- j) Minimum bend radius
 - i) During installation and post installation.
 - ii) As well as any additional information required by individual sections of this Division.

D. "Project Completion" phase submission:

1. As-built Drawings:

- a. Submit scaled layout drawings showing the routing of all backbone cabling, with pair/strand counts, cable types, type of pathway (cable tray, j-hooks, conduit, firestopping device) and final cable identifiers indicated for each cable. Ideally, this information would be indicated on scaled overall plans for each floor; however, it is permissible to combine with other Structured Cabling System Record Drawings for individual areas.

1.9 WARRANTIES

- A. Provide manufacturer warranties as required in Division 27 Section – "Structured Cabling System".

PART 2 - PRODUCTS AND MATERIALS

2.1 COPPER UNSHIELDED TWISTED PAIR CABLE

A. General

1. Requirements

- a. See drawings for required pair counts

- b. At a minimum, the cables shall meet the requirements of ANSI/TIA-568 for Category 3, 100-Ohm UTP Multi-pair Backbone Cable.
 - c. Cables shall consist of 24 AWG thermoplastic insulated conductors formed into binder groups of 25 pairs. Grouped and color coded as required by the referenced standards.
 - d. Cable construction specifications
 - 1) Core wrap – Polypropylene Film
 - 2) Shield – Corrugated Aluminum tape bonded to appropriately rated jacket
 - e. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name
 - 2) Copper Conductor Gauge
 - 3) Pair Count
 - 4) UL and CSA listing
 - 5) Manufacturer's Trade Mark
 - 6) Category rating
 - 7) Sequential distance markings, in one foot increments
2. Backbone cables for dry environments
- a. Requirements
 - 1) Cable jacket shall be riser (CMR or MPR) rated.
 - 2) Cable jacket shall be gray with black lettering.
 - b. Manufacturer shall be:
 - 1) Belden Incorporated
 - 2) CommScope Inc.
 - 3) Hubbell
 - 4) Legrand/Ortronics
 - 5) Leviton
 - 6) Panduit
 - 7) Siemon

- 8) Superior Essex Cabling
- 9) Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)
- 3. Backbone cables for Wet Locations (as defined in Division 27 Section “Structured Cable System”)
 - a. Requirements
 - 1) Cable construction shall be consistent with an outside plant cable and suitable for installation in a “wet” environment
 - 2) Suitable to be in contact with standing water
 - 3) Cable construction shall be consistent with manufacturer’s requirements to be covered under warranty specified in Division 27 Section “General Communications Requirements”
 - b. Manufacturer shall be:
 - 1) Belden Incorporated
 - 2) CommScope Inc.
 - 3) Hubbell
 - 4) Legrand/Ortronics
 - 5) Leviton
 - 6) Panduit
 - 7) Siemon
 - 8) Superior Essex Cabling
 - 9) Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

2.2 MULTI-MODE OPTICAL FIBER CABLE

A. General

- 1. Requirements
 - a. See Division 27 and backbone (riser) diagram(s) on the Drawings for required fiber counts.
 - b. Cable shall meet the transformation performance and physical specifications of ANSI/TIA-568.

- c. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name and trade mark
 - 2) Fiber size
 - 3) Fiber Grade
 - 4) UL listing (Shall be suitable for the application)
 - 5) Sequential length markings
 - d. Type: OM3
 - e. Cable jacket color shall be:
 - 1) AQUA for laser optimized multi-mode fiber optic cable
 - f. Fiber Size –50/125 μm
 - g. With a modal bandwidth of 2000 Mhz•km @ 850 nm/500 Mhz•km @ 1300 nm for laser optimized 50/125 μm
 - h. Maximum allowable attenuation (db/km) is 3.5 at 850nm and 1.5 at 1300nm.
- B. Intra-building; cables that remain within the envelope/footprint of the building that are not installed within pathways defined to be in “wet” locations
- 1. Requirements
 - a. Cable shall have an overall armor of steel or aluminum.
 - b. Cable jacket shall be plenum (OFNP | OFCP) rated.
- C. Intra-building; cables that remain within the envelope/footprint of the building that are installed within pathways defined to be in “wet” locations
- 1. Requirements
 - a. Cable shall have an overall armor of steel or aluminum
 - b. Cable jacket shall be indoor/outdoor plenum cable and suitable for installation such environments.
 - c. Cable jacket rating shall be consistent with manufacturer's requirements to be covered under warranty specified.

2.3 SPLICES (SPLICE CASES)

- A. In general, optical fiber cables are not to be spliced except where indicated otherwise in the Drawings and Specifications.
 - 1. Refer to Division 27 Section “Telecommunications Equipment Room Fittings” for splicing requirements integral to rack-mounted enclosures.
- B. Where splicing is indicated in the Drawings and Specifications, multi-mode and single-mode optical fiber cable splicing shall be fusion spliced. Provide splice case with trays to accommodate all fiber strands that enter case.
- C. Multi-mode and single-mode optical fiber cables shall be spliced at points indicated on the Drawings.
 - 1. End caps with hole configurations to meet cable sheath diameters without filters.
 - 2. Plugs for all unused end cap holes.
 - 3. Trays shall be used to hold all splices.
 - 4. Optical fiber cables shall be labeled between 6” and 12” from their entry to the splice case.
- D. Maximum allowable loss for splices is 0.3 db.
- E. Manufacturer shall be:
 - 1. Preformed Line Products – Coyote Fiber Optic Closures series
 - 2. Or approved equivalent

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer’s instructions.

3.2 CABLE INSTALLATION

- A. General:
 - 1. Place all backbone cabling in accordance with these specifications, on the Drawings and as indicated on any cable schedules.
 - 2. Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications.
 - a. There shall be no splices or mechanical couplers installed between the cable points of origin and termination except as shown on the Drawings and/or specified herein.

- b. There shall be no Bridged taps (multiple appearances of the same cable pairs at several distribution points) installed.
- 3. Unless otherwise noted, all cables shall be routed through the building cable tray/conduit/cable ladder system. Refer to the Telecommunications floor plan and detail drawings for the layout of the conduits, cable tray and cable ladder.
 - a. Backbone cables in which no portion of the cable jacket will be exposed when routed in a plenum or other air handling space, shall be riser rated (CMR, MPR, OFNR, or OFCR). Cables suitable for use in air plenums or other air handling spaces, and which meet the electrical/transmission specifications, are also acceptable for riser applications.
 - b. Backbone cables in which any portion of the cable jacket will be exposed when routed in an air plenum or other air handling space shall be plenum (CMP, MPP, OFNP, or OFCP) rated.
 - c. Backbone cables installed in “wet” locations as defined by the NEC or in these construction documents shall be suitable for installation in such environments and follow the installation requirements for outside plant cables as specified herein.
 - d. Backbone cables routed vertically within a Telecommunications Room shall be supported by velcro-attachment every 18” to vertically-mounted ladder rack or D-rings.
- 4. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.
 - a. Except when supported by ladder racking or D-rings within each Telecommunications room, UON.
- 5. All backbone cables running on ladder racking within all Telecommunications rooms throughout the building shall be neatly placed and secured to the horizontal and vertical ladder racking with cable lacing twine or nylon wire ties at intervals not to exceed every third rung plus all locations where the cable changes direction.
- 6. At the same time backbone cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. 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 cord.
- 7. Do not install 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.
- 8. Where distance allows all backbone cables shall be provided with slack/service loops at each end of the cable. Each slack/service loop shall be:
 - a. A minimum of (10) feet in length, UNO
 - b. Configured in a loosely formed figure eight configuration (ie. not coiled)

9. Prior to using any cable pulling lubricants provide the Design Consultant with written documentation from the cable manufacturer supporting the cable manufacturers' acceptance of its use in compliance with all required warranties as part of these contract documents. The use of non-water based lubricants shall be provided when pulling PVC jacketed and all cables not suitable for contact with water.
 10. Comply with all referenced standards and guidelines
 11. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.
 12. Where backbone cabling has a shield or metallic member, the shield or metallic member shall be bonded to the TMGB/TGB in accordance with ANSI/TIA-607 and BICSI/NECA 607-2011.
- B. Outside plant cable installation: for cables placed in "wet locations". These locations include but are not limited to; pathways that extend outside the envelope of the building such as aerial entrances, direct buried cables, underground conduits, conduits embedded in, or routed below a ground floor slab, etc.
1. Unlisted cables shall transition to an indoor rated cable within 50' of the entrance point as required the NEC.
 - a. This 50' allowed by code is only to allow termination as close as practicable to the entrance point. Terminate all outdoor only (unlisted) cables at the closest point of entrance and transition to an indoor rated cable to extend to additional Telecommunications rooms (spaces)
 2. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling spaces nor shall they be allowed to transition between different levels of the building.
 3. Where specifically allowed by these construction documents cable jackets rated for dual use by a NRTL, such as an indoor/outdoor rated cable may be used.
 - a. These cables may be installed in locations within the building in which the cable jacket is appropriately rated to meet all applicable building codes.
 4. Rigid metallic conduit shall be used to route outdoor (unlisted) cabling to within 50' of the transition point to indoor rated cabling in accordance with the NEC.
 5. Cables which extend beyond the envelope/footprint of the building shall be installed with entrance protectors in accordance with Division 27 Section "Communications Equipment Room Fittings".

3.3 COPPER CABLE INSTALLATION

A. General:

1. Place all backbone cabling in accordance with these specifications, and as indicated on the cable schedules and the Drawings.

2. Comply with all referenced standards and guidelines.
- B. Multi-pair Backbone Cable: All backbone cables shall run from the splice locations indicated in these specifications and on the copper cable backbone riser diagram through the dedicated pathways and spaces identified in the Telecommunications drawings and into their respective Telecommunications rooms. All cables shall be “punched down” on terminal blocks, as indicated in Division 27 Section “Communications Equipment Room Fittings”, in the Telecommunications rooms and on splice blocks at the splice locations.
- C. Intra-building; cables that remain within the envelope/footprint of the building
 1. Cables that are installed within pathways considered to be in “wet” locations
 - a. Follow the requirements for installing outside plant cables as specified in these contract documents

3.4 OPTICAL FIBER CABLE INSTALLATION

- A. General:
 1. Place all optical fiber backbone cabling in accordance with these specifications, and as indicated on the cable schedules and the Drawings.
 2. Splices between optical fiber cables are permitted only at those locations indicated on the Drawings.
 3. Splices between riser rated optical fiber cables and factory connectorized pigtails are permitted, but not required at each fiber termination location indicated on the Drawings. Pre-terminated riser cables meeting the material specifications may be utilized.
 4. Comply with all referenced standards and guidelines.
- B. Pre-installation testing:
 1. Optical fiber cables: Perform visible light continuity check on each fiber. If one end is not accessible: perform OTDR test to assure fiber continuity.
- C. Optical Fiber Backbone Cables:
 1. Place between the optical fiber Main Distribution Frame (MDF) and the Telecommunications rooms as noted in the cable schedules and the Drawings.
 2. Optical fiber cable is to be installed within inner duct at all locations where it is within nominal 4-inch conduit (not including short conduit sleeves.)
 3. Support optical fiber riser cables with suitable support grips. After being supported, the optical fiber cables will be routed over to the optical fiber patch panel in that particular Telecommunications room.

3.5 OPTICAL FIBER MAIN DISTRIBUTION FRAME

- A. Optical fiber cables shall be routed to the Fiber MDF from each of the Telecommunications Rooms via conduits, trays and riser sleeves. See the Drawings.
- B. Optical fiber cables shall enter the Fiber Distribution Frame from the top of the frame and then routed to the connector and splice modules/shelves.

3.6 CABLE IDENTIFICATION

- A. Label all backbone cabling with machine-printed labels according to the labeling scheme identified on the drawings. Where the drawings are silent, submit RFI through appropriate channels requesting labeling scheme.
- B. Cables shall be labeled within 6" at each end and within each pullbox.
- C. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:
 - 1. Brady, IDXPRT
 - 2. Hellermann Tyton, Spirit 2100
 - 3. Panduit LS9
 - 4. Or equivalent

3.7 CABLE TERMINATIONS

- A. Terminate all backbone cabling specified in accordance with Division 27 Section "Communications Equipment Room Fittings", No cables shall contain unterminated elements UON.

3.8 CABLE TESTING

- A. Refer to Division 27 Section "Structured Cabling System" for testing requirements.

3.9 ACCEPTANCE

- A. The Owner and Design Consultant reserves the right to observe the conduct of any or all portions of the testing process.
- B. All cables that fail testing are to be corrected prior to substantial completion and acceptance by owner. Replace entire cable if bad pair or strand is found.

END OF SECTION 271300

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. Provide a complete Category 6, and 6A horizontal (work area) telecommunications cabling system as shown on the TN sheets and in accordance with these Contract Documents.
- B. This section specifies the following:
 - 1. Horizontal Copper Cable
 - 2. Copper Connectivity
 - a. Faceplates
 - b. Modules/jacks/inserts
 - c. Surface Box

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions, requirements, and recommendations in Division 27 Section "General Communications Requirements"
- B. Refer to Division 27 Section "Common Work Results for Communications" for general pathway, firestopping, access panel, identification, and other requirements.
- C. Refer to Division 27 Section "Structured Cabling System" for Advanced System Warranty information and other requirements.
- D. Refer to Division 27 Section "Telecommunications Equipment Room Fittings" for telecommunications equipment racks, patch panels, wall-blocks, surge suppressors, and other equipment room requirements.

1.3 CODES, STANDARDS, AND GUIDELINES

- A. In addition to all applicable codes, standards, and guidelines listed in Division 27 Sections "General Communications Requirements" and "Structured Cabling System", follow the most recent editions of the following:
 - 1. NFPA 70 (NEC) – "National Electrical Code" (NEC)
 - 2. IEEE NESC - "National Electrical Safety Code"

3. ANSI/BICSI 005 – “Electronic Safety and Security System Design and Implementation Best Practices”
4. ANSI/NECA/BICSI-607 – “Standard for Telecommunications Bonding and Grounding Planning and Installation methods for Commercial Buildings”
5. ANSI/TIA-568 – “Commercial Building Telecommunications Cabling Standard Set”
6. ANSI/TIA-569 – “Commercial Building Standard for Telecommunications Pathways and Spaces”
7. ANSI/TIA-607 – “Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises”
8. ANSI/TIA-606 – “Administration Standard for Commercial Telecommunications Infrastructure”
9. BICSI – “Telecommunications Distribution Methods Manual”
10. BICSI – “Information Technology Systems Installation Methods Manual”
11. IEEE 142 – “Recommended Practice for Grounding of Industrial and Commercial Power Systems” (Green Book)
12. IEEE 1100 – “Recommended Practice for Powering and Grounding Electronic Equipment” (Emerald Book)
1. TIA-526 – “Standard Test Procedures for Fiber Optic Systems”
13. TIA-TSB-140 – “Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems”

1.4 DEFINITIONS

- A. Advanced System Warranty – refer to Division 27 Section “Structured Cabling System”.
- B. Communications Equipment Room - This CSI MasterFormat term shall apply to spaces specifically designed to maintain communications equipment. This definition shall encompass ANSI/TIA-569 terms for Entrance Room, Common Equipment Room (CER), and Common Telecommunications Room (CTR). This definition also shall encompass BICSI Telecommunications Distribution Methods Manual terms for Telecommunications Room (TR), Telecommunications Enclosure (TE), Equipment Room (ER), and Entrance Facility (EF).
- C. Direct Attach Method – as defined in ANSI/BICSI 005-2013, the horizontal cabling on the remote device end directly attaching (or connecting) to the device through a connectorized cable or hard-wired termination, eliminating the workstation outlet, jack and equipment cord.
- D. Horizontal Cabling
 1. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the

communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

- a. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector
 - b. Bridged taps and splices shall not be installed in the horizontal cabling
 - c. Splitters shall not be installed as part of the optical fiber cabling
2. A work area is approximately 100 sqft (9.3 sqm), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
 3. The maximum allowable horizontal cable length is 295 feet (90 meter). This maximum allowable length does not include an allowance for the length of 16 feet (4.88 meter) to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet (4.88 meter) in the horizontal cross-connect.
- E. Structured Cabling / Telecommunications System – a fully-functional passive telecommunications system (infrastructure), that includes permanently installed copper Category and fiber optic cable terminated onto a patch panel or outlet.

1.5 QUALITY ASSURANCE

- A. As a minimum, the person(s) conducting the testing for all Telecommunications cabling shall be a current BICSI Certified Level II Commercial Installer or higher.
- B. All testing equipment used shall have the latest version of software and/or firmware installed prior to testing any cabling. Testing equipment shall also undergo all manufacturers' required and recommended routine maintenance.

1.6 SUBMITTALS

- A. Follow the requirements for submittals in Division 27 Section "General Communications Requirements"
- B. The following submittals are due at the "pre-bid" phase submission
 1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Engineer. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.
- C. The following submittals are due at the "pre-construction" phase submission
 1. Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters)

2. Submit manufacturers' cut sheets or catalog cut sheets for:
 - a. Each of the cables specified. Cut sheets shall include the following information at a minimum:
 - 1) Manufacturers name and logo
 - 2) Cable outside diameter
 - 3) Number of conductors/strands in each cable and binder group
 - 4) Gauge or strand thickness
 - 5) Minimum transmission performance rating
 - 6) Cable jacket material and rating
 - 7) Maximum pulling tension
 - 8) Jacket/Sheath color
 - 9) Individual conductor or strand insulation colors
 - 10) Minimum bend radius
 - a) During installation and post installation.
 - b) As well as any additional information required by individual sections of this Division.
 - b. Faceplates and modules. Cut sheets shall include the following information at a minimum:
 - 1) Manufacturers name and logo
 - 2) Material type
 - 3) Performance rating
 - 4) Physical Dimensions
 - 5) Color
 - c. Product information of test equipment to be used for the testing of cabling.
 - d. Provide documentation indicating manufacturer required and recommended maintenance and calibration services and intervals at which these services shall be performed.
 - 1) Provide documentation indicating the dates at which all testing units have undergone these services. For services required on a daily or pre-test basis provide documentation on the procedures the contractor will undergo for performing such services.

3. Shop Drawings
 - a. Submit for review scaled layout drawings showing the routing of all cabling, and the locations where terminal blocks, patch panels, Telecommunications outlets, cable types, cable jacket listing information, firestop locations (with quantity and NRTL system number identified), furniture feed points, and fiber optic termination panels are to be installed.
 - b. Shall show the number of horizontal cables served by each room and the number of patch panels and termination blocks to be installed (including those to accommodate 25% growth).
 - c. Each individual outlet on the drawings shall have proposed outlet identification indicated.
 - d. Unless otherwise required by these specifications, it is permissible to show different cabling systems (voice, data, CATV, A/V) on the same shop drawing.
 4. Testing
 - a. Qualifications: Identity and qualifications of the personnel who will perform the testing as required above in the Quality Assurance paragraph.
 - b. Submit all physical characteristics needed for appropriate testing setup and verification. I.e. Nominal velocity of propagation (NVP) for each and every cable type. This parameter shall be identified and submitted for review. Such submittals for all parameters shall be from printed manufacturers' cut-sheets or other manufacturers' printed material.
 - c. Submit the proposed schedule for performing testing at least 2 weeks prior to the start of testing.
 5. Sample warranty information as indicated herein and elsewhere in this Division.
- D. The following submittals are due at the "Project Completion" phase submission
1. As-built Drawings
 - a. Submit scaled layout drawings showing the routing of all cabling, and the locations where terminal blocks, patch panels, Telecommunications outlets, cable types, cable jacket listing information, firestop locations (with quantity and NRTL system number identified), furniture feed points, and fiber optic termination panels have been installed.
 - b. Shall show the number of horizontal cables served by each room and the number of patch panels and termination blocks installed (including those to accommodate 25% growth).
 - c. Unless otherwise required by these specifications, it is permissible to show different cabling systems (voice, data, CATV, A/V) on the same As-built drawing.
 2. After approval by the Owner, submit the test results in computer readable copy in CD, DVD or mutually acceptable format by the Contractor and Owner.
 3. Advanced Structured Cabling System Warranty Certificate

1.7 WARRANTIES

- A. Provide manufacturer warranties as required in Division 27 Section “Structured Cabling System”.

PART 2 - PRODUCTS AND MATERIALS

2.1 HORIZONTAL (WORK AREA) COPPER CABLE

- A. Horizontal cables for dry environments

- 1. Requirements

- a. Unshielded Twisted Pair (UTP)
- b. Minimum performance specifications: Cable shall meet requirements for Category 6 and Augmented Category 6 (for wireless access points only) of ANSI/TIA-568.
- c. Four pairs of 22-24 AWG solid copper conductors
- d. Cable jacket color(s) shall be
 - 1) Blue for general horizontal cabling
 - 2) Green for security cameras
 - 3) Purple for wireless access points.
- e. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name
 - 2) Copper Conductor Gauge
 - 3) Pair Count
 - 4) UL and CSA listing
 - 5) Manufacturer's trade mark
 - 6) Category rating
 - 7) Sequential distance markings, in one foot increments
- f. Individually insulated conductors under a common sheath
- g. Plenum (CMP or MPP) rated.

- 2. Manufacturer shall be:

- a. CommScope Inc.
 - b. Hubbell
 - c. Legrand/Ortronics
 - d. Leviton
 - e. Panduit
 - f. Siemon
 - g. Superior Essex Cabling
 - a. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)
- B. Horizontal cables for Wet Locations (as defined in Division 27 Section “Structured Cable System”)
- 1. Requirements
 - a. Suitable to be in contact with standing water
 - b. Cable construction shall be consistent with manufacturer’s requirements to be covered under warranty specified in Division 27 Section “General Communications Requirements”.
 - c. Minimum performance specifications: Cable shall meet requirements for Category 6 of ANSI/TIA-568.
 - d. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer’s name
 - 2) Copper Conductor Gauge
 - 3) Pair Count
 - 4) UL and CSA listing
 - 5) Manufacturer’s trade mark
 - 6) Category rating
 - 7) Sequential distance markings, in one foot increments
 - 2. Product shall be:
 - a. CommScope Inc.
 - b. Hubbell

- c. Legrand/Ortronics
- d. Leviton
- e. Panduit
- f. Siemon
- g. Superior Essex Cabling
- a. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

2.2 FACEPLATES FOR COPPER CONNECTIVITY

A. Single-gang faceplate:

1. Requirements

- a. Stainless Steel with number of ports to allow all modular jacks to be installed as required, and as indicated on the drawings.
- b. Color shall match electrical, U.O.N. by owner
- c. Single gang, U.O.N

2. Product shall be

- a. CommScope Inc.
- b. Hubbell
- c. Legrand/Ortronics
- d. Leviton
- e. Panduit
- f. Siemon
- g. Superior Essex Cabling
- h. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

B. Double-gang faceplate:

1. Requirements

- a. Stainless steel with number of ports to allow all jacks to be installed as required, and as indicated on the drawings.
 - b. Color shall be match electrical, U.O.N. by owner
 - c. Double gang, U.O.N
 - 2. Product shall be
 - a. CommScope Inc.
 - b. Hubbell
 - c. Legrand/Ortronics
 - d. Leviton
 - e. Panduit
 - f. Siemon
 - g. Superior Essex Cabling
 - h. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)
- C. Weatherproof faceplate:
- 1. Requirements
 - a. Water resistant faceplate (to IP56 rating, or equivalent) with number of ports to allow all jacks to be installed as required, and as indicated on the drawings.
 - b. With in-use cover
 - 2. Product shall be:
 - a. Panduit Mini-Com Water Resistant Faceplate with integral cover.
 - b. Hubbell RW57300 (Or Approved Equivalent) with decora-insert and jacks from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements).

2.3 COPPER CONNECTIVITY

A. Modular jacks

- 1. Requirements

- a. Outlets shall meet requirements for Category 6(Augmented Category 6 for wireless access points only) of ANSI/TIA-568.
 - b. All 8-position modular jacks are to be wired according to the TIA T568A/B pin/pair assignments.
 - c. Outlet hardware shall be UL listed.
 - d. One port
 - e. Color shall match electrical, U.O.N. by owner
 2. Product shall be
 - a. CommScope Inc.
 - b. Hubbell
 - c. Legrand/Ortronics
 - d. Leviton
 - e. Panduit
 - f. Siemon
 - g. Superior Essex Cabling
 - h. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)
- B. Blank inserts
1. Requirements
 - a. Provide blank modules to fill any unused openings in faceplates
 - b. Color shall match other jack colors
 2. Product shall be
 - a. CommScope Inc.
 - b. Hubbell
 - c. Legrand/Ortronics
 - d. Leviton
 - e. Panduit

- f. Siemon
- g. Superior Essex Cabling
- h. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 CABLE INSTALLATION

A. General

1. Place all horizontal cabling in accordance with these specifications, on the Drawings, and as indicated on any cable schedules
2. Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications.
 - a. There shall be no splices or mechanical couplers installed between the cable points of origin and termination except as shown on the Drawings and/or specified herein.
 - b. There shall be no Bridged taps (multiple appearances of the same cable pairs at several distribution points) installed.
 - 1) Horizontal cabling shall be terminated in a Telecommunications room that is on the same floor as the area (outlet) being served in accordance with ANSI/TIA-568.
 - 2) No horizontal cables shall exceed the allowed maximum distance of 295 feet (90 meters) by ANSI/TIA-568.
3. Unless otherwise noted, all cables shall be routed through the building cable tray/conduit/surface-mounted raceway system. Refer to the electrical drawings for the layout of the conduits. Refer to the Telecommunications drawings for layout of cable tray.
 - a. All horizontal cables shall be plenum (CMP, MPP, OFNP, or OFCP) rated. UON
 - b. Horizontal cables installed in "wet" locations as defined by the NEC or in these construction documents (such as conduits embedded or routed below a ground floor slab) shall be suitable for installation in such environments and follow the installation requirements for outside plant cables as specified herein.
4. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire

ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.

- a. Except when supported by ladder racking within each Telecommunications room, UON.
 5. At the same time horizontal cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200 lb (90.72 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
 6. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable
 7. Comply with all referenced standards and guidelines.
 8. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.
 9. Where distance allows all horizontal cables shall be provided with slack/service loops at each end of the cable, one at the work area outlet and one at the Telecommunications room/enclosure. Each slack/service loop shall be:
 - a. A minimum of 8 feet (2.44 meter) in length, UNO
 - b. Configured in a loosely formed figure eight configuration (i.e. not coiled)
 10. Prior to using any cable pulling lubricants provide the Engineer with written documentation from the cable manufacturer supporting the cable manufacturers' acceptance of its use in compliance with all required warranties as part of these contract documents. The use of non-water based lubricants shall be provided when pulling PVC jacketed and all cables not suitable for contact with water.
- B. Outside plant cable installation: for cables placed in "wet locations" or as required by these construction documents. (I.e. all cables which extend beyond the footprint/envelope of the building or pathways leading to floor-boxes embedded in a ground floor slab)
1. Unlisted cables shall transition to an indoor rated cable within 50 feet (15.24 meter) of the entrance point as required the NEC.
 - a. This 50 feet (15.24 meter) allowed by code is only to allow termination as close as practicable to the entrance point. Terminate all outdoor only (unlisted) cables at the closest point of entrance and transition to an indoor rated cable to extend to additional Telecommunications rooms (spaces)
 2. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling space nor shall they be allowed to transition between different levels of the building.
 3. Where specifically allowed by these construction documents cable jackets rated for dual use by a NRTL, such as an indoor/outdoor rated cable may be used.

- a. These cables may be installed in locations within the building in which the cable jacket is appropriately rated to meet all applicable building codes.
 4. Rigid metallic conduit shall be used to route outdoor (unlisted) cabling to within 50 feet (15.24 meter) of the transition point to indoor rated cabling in accordance with the NEC.
 5. All cables which extend beyond the envelope/footprint of the building shall be installed with entrance protectors in accordance with Division 27 Section “Communications Equipment Room Fittings”
- C. Horizontal (work area) Cables:
1. From the appropriate Telecommunications room, provide each work area outlet, the types and quantities of horizontal cables as described in the applicable system specification sections. Cables will leave the Telecommunications room via cable tray, conduit/sleeve or floor duct. Each cable will be terminated except for pay phone and elevator machine room junction box locations.
 2. Install all horizontal cables in accordance with Division 27 Section “Common Work Results for Communications” and as indicated on the drawings.

3.3 CABLE & WIRE INSTALLATION

- A. General:
1. Place all station cabling in accordance with these specifications, and as indicated on the cable schedules and the Drawings.
- B. Station Cables:
1. Install station cabling, outlets and jacks as detailed in the horizontal cable placement schedules and the Drawings. The typical configuration for outlets shall be two unshielded twisted pair (UTP) cables of 4-pairs each, unless otherwise noted on the drawings or the Horizontal Cable Placement Schedules.
- C. Cables located in “wet” locations
1. Provide all required entrance protection in accordance with Division 27 “Communications Equipment Room Fittings”.
 2. Follow the requirements for installing outside plant rated cable as specified in Division 27 Section “Communications Horizontal Cabling”
 3. All cables routed to floor boxes in the slab shall route to a transition box within 50 feet (15.24 meter) of where the conduit emerges from the slab. Provide connecting hardware within an appropriately rated enclosure to allow a transition from outside plant cable to indoor rated cable. Indoor rated cable shall be rated as required by building code and as specified herein. Route indoor cables as indicated for horizontal cable distribution. Transition hardware shall meet or exceed the category performance of the highest rated cable being terminated.

- a. Cables from multiple different floor boxes may be routed to a single, appropriately sized, transition enclosure.

3.4 CONNECTOR INSTALLATION

- A. Furnish and install all cable connectors as shown on the Drawings.
- B. Provide number of connectors as required by the Drawings and as required by these documents, where the number of connectors required does not fill the entire faceplate provide blank inserts so that no opening is left.
- C. The provision and termination of connectors from each cable shall be done as follows:
 1. Where connector types are identified on the applicable drawings or in the specifications, furnish and install the specified connectors on the specified cables. Installation of the connectors shall be in accordance with the manufacturer's printed instructions.
 2. All installed connectors, regardless of type, method of procurement or permanency, shall be adequately protected during and after installation.
- D. Copper Connector Installation
 1. Terminate all four pairs of each cable on one outlet jack.
 2. Furnish and install all cable connectors as shown on the Drawings or as indicated herein, unless otherwise noted.
 3. The provision and termination of connectors for each cable shall be done as follows:
 - a. Where connector types are identified on the applicable drawings or in the specifications, Furnish and install the specified connectors on the specified cables. Installation of the connectors shall be in accordance with the manufacturer's printed instructions.
 - b. All installed connectors, regardless of type, method of procurement or permanency, shall be adequately protected during and after installation.

3.5 FLOORBOX LOCATIONS

- A. Refer to Division 27 "Common Work Results for Communications" for size, type, and specifications.
 1. Provide appropriate mounting brackets (as required), faceplates, modular jacks, inserts, mounting frames and cabling required to fully populate and provide a fully functional system.
- B. For slab-on-grade floorbox locations, coordinate with the Common Work contractor to extend underground or in-slab conduit all of the way to the serving Telecommunications Room. If that is not practical, coordinate with Common Work contractor on stub-up location and overhead enclosure size/location to transition OSP (wet-rated) cable to plenum-rated cable.

1. Note underground conduit routing and overhead transition point locations on pre-construction shop drawings and Record Drawings.

3.6 FACEPLATE INSTALLATION

- A. Furnish and install all faceplates in locations as shown on the Drawings.

3.7 CABLE IDENTIFICATION

- A. Label all horizontal cabling with machine-printed labels according to the labeling scheme identified on the drawings. Where the drawings are silent, submit RFI through appropriate channels requesting labeling scheme.
 1. Shop drawings shall include floor plan that indicates proposed cable/outlet identification for each outlet.
- B. Cables shall be labeled within 6" at each end.
- C. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:
 1. Brady, IDXPRT
 2. Hellermann Tyton, Spirit 2100
 3. Panduit LS9
 4. Or equivalent

3.8 CABLE TERMINATIONS

- A. Terminate all horizontal cables in accordance with Division 27 Section "Communications Equipment Room Fittings". No cables shall contain unterminated elements UON.

3.9 CABLE TESTING

- A. Refer to Division 27 Section "Structured Cabling System" for testing requirements.

3.10 ACCEPTANCE

- A. The Owner and Design Consultant reserves the right to observe the conduct of any or all portions of the testing process.

- B. All cables that fail testing are to be corrected prior to substantial completion and acceptance by owner.
Replace entire cable if bad pair or conductor is found.

END OF SECTION 271500

SECTION 274100 - AUDIO VIDEO SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. These specifications and the associated TA-series drawings describe the sound and audio-video (AV) system (hereafter referred to as the “Technical System”) requirements to be furnished and installed as a portion of the project scope of work.
- B. System is intended for support of educational activities in the classrooms, Band room, and percussion room and athletic/assembly activities in the Gymnasium. Not intended for live high-energy entertainment.
- C. Work includes all such work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Communications, Fire Alarm and Electronic Safety and Security Drawings and Specifications; and Addenda.
- D. Work under this section of the specifications includes all labor, equipment, and installation as required to provide a complete technical system in compliance with the contract documents.
- E. Employ the services of a qualified structural engineer to review all overhead mounting and suspension details of the technical system equipment. All mounting and suspension schemes indicated on the drawings are shown for concept only. Submit shop drawings stamped by a structural engineer of all details and weights for review by the project’s Architect, Structural Engineer, and Design Consultant.
- F. The work in this section shall be coordinated with other work to determine installation scope for conduit, outlet boxes, junction boxes, pull boxes, terminal cabinets, 120-volt AC power circuits, and insulated ground cables required for the technical system.
 - 1. Provide related low-voltage “on/off” AC power control system wiring, low-voltage “on/off” control switches, and certain AC power/ground requirements internal to the equipment racks as specifically noted herein and/or on the drawings.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section, as do the following:
 - 1. Division 27 Section “General Communications Requirements”.
 - 2. Division 27 Section “Common Work Results for Communications”.
- B. All Category cabling and terminations shall adhere to the Division 27 Section “Telecommunications Requirements for Audio Video Systems”.

- C. This section is a parent section to all sections numbered 274101 thru 274199. Requirements found in this section shall apply to all child sections unless otherwise noted.

1.3 EXAMINATION OF SITE

- A. This project is an existing facility undergoing expansion and renovation.
- B. Prior to submitting a bid personally examine the site of the proposed work and verify the conditions which involve his work.
- C. By the act of submitting a bid, the contractor will be deemed to have made reasonable allowances for site examinations, site conditions, and included all costs in his proposal. Failure to verify these conditions will not be considered a basis for the granting of additional compensation.

1.4 MATERIAL AND WORKMANSHIP

- A. All equipment shall be new and in proper operating condition. All workmanship shall be of the finest quality by experienced installation technicians.
- B. Contact the Architect, in writing, regarding the selection of colors for all exposed equipment.
- C. In addition to a complete set of the system project drawings and specifications, maintain at the job site a complete set of manufacturer's original operation, instruction, installation, and service manuals for each equipment item, for reference.

1.5 ORDINANCE AND CODES

- A. Comply with all applicable national and local codes and ordinances, and obtain all required permits. Assume responsibility for any violations of the law within the scope of his work.

1.6 DEFINITIONS

- A. Structured Cabling System – the physical infrastructure installed to support information technology/transport for voice and data applications, commonly referred to as a Telecommunications System. This includes, but is not limited to: Category copper cabling, terminations/blocks, modules, faceplates, etc., and optical fiber cabling, terminations, modules, etc.

1.7 QUALITY ASSURANCE

- A. Contractor General Qualifications:
 - 1. Compliance with the requirements of Division 1.
 - 2. Licensed to perform work of this type in the project jurisdiction.

3. At least five (5) years of verifiable direct experience with the devices, equipment and systems of the type and scope specified herein.
 4. Prior successful experience of projects of similar size, scope and type as outlined in the Construction Documents.
 5. Active membership in the National Systems Contractors Association (NSCA).
 6. Active membership in The Audiovisual and Integrated Experience Association (AVIXA).
 7. Fully staffed and equipped maintenance and repair facility.
 8. Factory-authorized dealer for the major components specified.
- B. Contractor Personnel Qualifications:
1. Skilled workers 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 in this section. The workers shall have at least three (3) years direct experience in similar work, evidence of which shall be verified in writing with appropriate references.
 2. Supervisor with at least five (5) years direct experience in similar work. The supervisor shall be present for and in responsible charge of all work in the fabrication shop and on the project site during all phases of the installation and testing of the system(s). To assure continuity, this supervisor shall be the same individual throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene. This person shall act as the Technical System Project manager, and shall attend all scheduled project meetings.
- C. Provide additional information as required for review by the Owner's Representative, Architect, and Design Consultant to aid in proving acceptability.

1.8 SUBSTITUTIONS

- A. Substitutions of equipment/materials will be considered for approval. The contractor shall bear the "burden of proof" for demonstrating substitute equipment/materials' equivalency and suitability.
- B. Requests for substitution of equipment/materials shall comply with Division 01 regarding the proposed substitute item(s), specifications, and front/rear views (if applicable).
- C. In the absence of Division 01 specifications on substitutions, information regarding substitution of equipment/materials shall be presented in writing to the Owner's Representative, Architect, and Design Consultant for review. This written request shall contain copies of complete manufacturer's literature regarding the proposed substitute item(s), specifications, and front/rear views (if applicable). The request shall also include detailed information regarding the reason for the proposed substitution.
- D. Submission of substitute equipment/materials (including any associated software) may be required for evaluation by the Design Consultant, at his discretion, prior to acceptance, and subject to evaluation fees. Contractor shall be responsible for the substituted equipment/materials and for all related shipping costs and evaluation fees.

- E. Replace any and all approved, installed substitute equipment/materials if an unforeseen defect appears, or if operational characteristics do not fulfill the design intent of the system.

1.9 SUBMITTALS

- A. Refer to requirements in Division 27 Section “General Communications Requirements”.
- B. Include the following items:
 - 1. Bid
 - a. Contractor Qualifications
 - b. Personnel Qualifications
 - c. Voluntary Bid Alternates shall not be allowed
 - 2. Pre-Construction
 - a. Equipment List
 - b. Product substitutions per this division
 - c. Product substitutions for discontinued products, in accordance with Division 1
 - d. Manufacturers’ Cut-sheets
 - 1) Minor pieces of equipment that are not visible and inconsequential to system operation may be included on Equipment List and no cut-sheet is required.
 - e. Schedule
 - 1) Include quiet time on-site for system Commissioning.
 - f. AV Pathways and Cabling – Follow requirements of Division 27 Section “Common Work Results for Communications”.
 - g. Structural Details – Suspended Devices
 - 1) No suspended device shall be installed prior to the final approval of Structural Detail Submittals by the Consultant.
 - 2) For suspended equipment and equipment racks, provide detailed, dimensioned drawings of each suspension hardware assembly. Also indicate location relative to structure, location relative to suspended component(s), configuration of suspended components (i.e., loudspeakers), attachment to structure, suspension method, and calculations.
 - a) Calculations shall include weights of supported equipment including installation hardware, and details of all installation hardware including:

manufacturer(s), part number(s) and pertinent technical information (i.e., Working Load Limit) of each part including nuts, bolts, and other accessories. All weight bearing hardware must be traceable, load rated, and domestically manufactured. All welds must be certified.

- 3) These drawings must be approved and stamped by a licensed structural engineer prior to submission. The following guidelines are applicable:
 - a) Contractors participating in the overhead installation of audio and/or video system components shall conform to industry best practice standards as set forth in:
 - i) “Basic Principles for Suspending Loudspeaker Systems” (JBL Professional Technical Note Volume 1, Number 14); and
 - ii) ANSI E1.6-2 -2013 (Entertainment Technology – Design, Inspection, and Maintenance of Electric Chain Hoists for the Entertainment Industry); and
 - iii) ANSI E1.6-3- 2012 (Selection and Use of Serially Manufactured Chain Hoists in the Entertainment Industry).
 - b) All suspended loudspeakers shall conform to ANSI E1.8-2012 (Entertainment Technology—Loudspeaker Enclosures Intended for Overhead Suspension—Classification, Manufacture and Structural Testing).
- h. Equipment Rack Shop Drawings - Equipment rack front elevation showing equipment, panel layout, and AC circuiting per device.
- i. Panel, Patch Panel, and Plate Shop Drawings - All panel, patch panel, and plate layouts indicating locations of connectors, engraving, nomenclature, panel material, and finish. Include Structured Cabling Work required by the technical system.
- j. Refer to child sections for additional requirements.
3. Project Completion
 - a. Refer to Division 27 Section “General Communications Requirements” and the Record Drawings and Operation and Maintenance Data sub-sections in Part 3 of this section for requirements.
 - b. Preliminary Testing Documentation Package – Provide preliminary results of system testing as described in Part 3 of this section for review prior to Commissioning. Include final results with Closeout Documentation.
 - c. Refer to child sections for additional requirements.

1.10 ELECTRONIC FILE SHARING

- A. Refer to Division 27 Section “General Communications Requirements” for information on obtaining electronic versions of the construction drawings.

1.11 PROTECTION OF WORK

- A. Protect all work, materials and equipment from damage due to any cause. Provide for the safety and new condition of the equipment and materials until final acceptance by the Owner's Representative. Replace all damaged or defective materials and/or equipment as directed by the Architect or Design Consultant.
- B. Equipment racks, cabling racks, junction boxes, termination boxes, and other exposed equipment shall be kept covered and protected from airborne contaminants. Clean all debris from the equipment room(s)/location(s) and control areas, and clean all equipment and the interior rack floor, prior to system commissioning activities.

1.12 TEMPORARY TECHNICAL SYSTEM

- A. Provide and operate a temporary technical system of reasonably equivalent function as determined by the Design Consultant if the work in this section, as a failure of the contractor, is incomplete or found not in conformance with the contract documents. The temporary system shall remain in use until acceptance of the permanent system.

1.13 WARRANTY

- A. Warrant all work executed under this contract, including all in-shop and onsite material, parts and labor, for a period of twelve months after the date of final acceptance.
 - 1. Existing or any other Owner-furnished equipment shall not be included in this warranty.
 - 2. For equipment that has an advertised manufacturer's warranty longer than 12 months, include end date of warranty period.
- B. The warranty services are limited to normal business hours, unless additional agreements are made between the Owner's Representative and the contractor.
- C. Warranty work relating to technically complex equipment and/or programming such as for codecs, digital signal processing, control systems, and video projectors shall be performed by a factory authorized technician.
- D. Damage to the system resultant from improper use or adjustment by others, negligence, acts of nature, or other causes which are beyond the contractor's control shall be excluded from the warranty.
- E. Refer to General Conditions for additional requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Unless otherwise designated, provide all of one type of equipment from one manufacturer; for example, microphones of one type by one manufacturer, data switches of one type by one manufacturer, cabling of one type by one manufacturer, or loudspeakers of one type by one manufacturer.
- B. Equipment and wiring shown on the drawings represents the basis of design. Ensure similar or better performance is achieved by the use of equipment other than that shown.
- C. All major components of technical system equipment shall be provided and installed by a qualified contractor as outlined in Part 1 of this section.
- D. All equipment shall be new and of professional quality.
- E. Some items listed in these specifications are custom-made products. Ensure when pricing and ordering equipment that the exact part number called out is used. If there is a discrepancy, contact the Design Consultant for clarification.
- F. Each software programmable device furnished (i.e. Digital Signal Processor, control system, etc.) shall include most recent software and appropriate computer interface cable - minimum 25' (device to PC). Cable, software, source (uncompiled) code and all related aspects of all software-controlled equipment shall become the property of the Owner and will be furnished as a portion of the Operation & Maintenance (O&M) manuals (see Operation & Maintenance Manuals near the end of Part 3).
- G. The quantities of each item of portable or mobile equipment (and other portable or loose accessories), as well as those items associated with Alternates, are indicated in parenthesis. Such equipment is intended to be shared between rooms having technical systems, except where noted for use in one specific room.

2.2 WIRELESS SYSTEM INTERFACE

- A. Wireless Control Pad, wireless control pad equipped with the necessary applications to allow for consistent operation from within the room or system, 10 hour battery life, approximately 10" x 8" x .5", with maximum storage available at time of purchase, and protective case and stylus (one required):
 - 1. Apple new iPad Wi-Fi 128GB with included power supply and add-on protective case such as the Incase Book Jacket Select for Apple new iPad (Black) and add-on pen/stylus such as the Kensington Virtuoso Touch Stylus & Pen.
 - 2. Register the iPad on an Owner's Representative-approved computer.
 - 3. Load with all applications available to components within this system.
 - 4. Furnish one Splashtop app when accessing a PC as a remote desktop.

2.3 FLAT PANEL DISPLAY/TELEVISION MOUNTS

- A. Unless noted otherwise, provide the appropriate mount for each display furnished. Mount color as selected by Architect. Match mount to the display and the mounting surface.
- B. Full assembly (display, mount, and all associated connections/equipment) shall be adequately supported with the appropriate safety factor to building structure. Appropriate structural backing/support shall be provided. No mounts shall fasten directly to the roof deck. Refer to submittal requirements.
- C. Furnish all components to provide a complete installation, including fastening systems suitable for the mounting surface.
- D. All recessed or built-in displays/televisions require shop drawings showing the surrounding architecture to ensure proper fit and ventilation requirements.
- E. Articulating Flat Panel Wall Mount: articulating arm mount that pulls out, rotates, and tilts down, fully adjustable, lockable, sized for display as required:
 - 1. Chief TS***T Series; or
 - 2. Peerless SA Series; or
 - 3. Premier Mounts AM Series.

2.4 A/V CONTROL SYSTEM – GENERAL PROGRAMMING REQUIREMENTS

- A. Participate in planning meeting (web/phone) with Design Consultant and Owner's Representative to review programming concepts and requirements before commencement of work.
- B. Operational and control system programming concepts including navigational flow, panel layout and/or button layout shall be developed during planning meeting(s) with Design Consultant and Owner's Representative.
- C. Refer to submittal requirements for additional information.
- D. This specification describes the initial touch screen and button station programming concepts and requirements. Account for 6 man-hours over 2 months after the system is substantially complete for revisions requested by the Owner's Representative.
- E. Touch screen user interfaces shall comply with the following minimum requirements:
 - 1. Touch screen control interfaces shall follow the guidelines outlined in the "Dashboard for Controls" documents created on behalf of AVIXA International. Reference the Design Guide, Design Reference, and Integrators Guide for this project. Documents are available for download on the AVIXA web site.
 - 2. A common theme shall be employed and used with consistency throughout the layouts. Theme shall be discussed with the Client Owner's Representative and the Client's Owner's standard theme template shall be used if available.

3. Where Owner logos or colors are used, Owner branding guidelines shall be followed. Trademarks shall be used appropriately. Official graphical representations (logos, word marks, logotypes, etc.) may not be altered. Owner colors shall utilize official and exact color (Pantone, CMYK, RGB, hex, etc.) as provided by the Owner, visual matching is not allowed. Content shall be obtained from an official and authorized source, e.g., the use of content from Google images is not appropriate. Owner branding is encouraged where appropriate; however, proper use and compliance remains the responsibility of the contractor.
4. The use of a password shall be employed as directed by the Client Owner's Representative as they deem appropriate.
5. Power ON/OFF sequence shall control all applicable devices. Sequence time shall be the required time for all controlled devices to cycle. Projector lamp warm-up and cool-down period shall be taken into account. Shutdown shall utilize two-step verification.
6. Animated activity indicators (spinning ring, progress bar, etc.) shall be utilized to provide visual feedback for background processing and tasks. This will prohibit multiple button presses by the user and show feedback that the control system is processing the request. Relevant text shall be utilized where appropriate, e.g., "Please wait while the system shuts down."
7. Operation selection "Presentation" or "Production" shall be available from the home page.
8. Source selection shall be available for all devices. Sources shall be laid out and grouped in a logical manner. A 'blank source' or 'image blanking' feature shall be utilized where relevant.
9. Button presses shall show instant visual feedback that they have been engaged.
10. Current system status shall always be visible and be consistent across all adjoined screens. Buttons shall show status (engaged or disengaged) via color, illumination, outline, greyscale, etc. as relevant. Sliders and level indicators shall show current and true system status (i.e. show true level based on system feedback, not status based on last touch screen input) via color, knob location, percentage, etc. as relevant.
11. Volume control of wired microphones, wireless microphones, and/or AV system program volume levels shall be discrete and shall be properly interfaced with the DSP (where applicable). The use of a master volume control or the like is prohibited.

2.5 CABLE - BULK

- A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this section does not indicate a requirement for use.
- B. Product must be procured from the original cable manufacturer.
- C. AWG wire sizes indicated herein or on the drawings are the minimum size conductors required. Larger size conductors (i.e., smaller AWG number) are permitted assuming no impact on the project will occur (such as the resulting need for larger or additional conduit, cable trays, chases, etc.) to accommodate such cable.
- D. Where cable is run exposed (such as in ceiling plenums, cable trays, chases, or below accessible floors):

1. Verify which locations do and do not require plenum-rated cable.
 2. Furnish the appropriate cable type.
 3. Obtain written authorization from the Architect (or the Architect's designated Engineer) in this regard.
- E. Category cabling:
1. Refer to Division 27 Section "Telecommunications Requirements for Audio Video Systems" for product information and additional installation requirements.
- F. 22 AWG/NP, microphone or line-level circuits installed in conduit or equipment racks, 22 AWG, 2-conductor shielded, PVC jacket – not plenum rated:
1. Belden 8451, or Gepco SAHS122R; or
 2. Belden 9451, or Clark Wire SPA22GS, or Gepco 61801EZ; or
 3. Belden 5500FE, or Gepco SSS222R; or
 4. Belden 9451D (dual), or Clark Wire RS22G2 (dual), or Gepco D61801EZGF (dual); or
 5. Belden 8422, or 8412 (20AWG); or
 6. West Penn 291, or Gepco SSS222R; or
 7. West Penn 452; or
 8. West Penn 454, or Clark Wire SPA22GS, or Gepco SAPS122R.
- G. 22 AWG/P, microphone or line-level circuits installed in a return-air plenum without conduit, 22 AWG, 2-conductor shielded, plenum rated:
1. Belden 9451P or Gepco 61801HS; or
 2. Belden 6500FC; or
 3. Belden 9451DP (dual); or
 4. Clark Wire SPA22GSP; or
 5. West Penn 25291B or Gepco SSS222P.
- H. 22 AWG MC/NP, microphone or line-level multi-conductor cables installed in conduit (not for interconnection within equipment racks), 22 AWG individually shielded pairs, color coded, PVC jacket – not plenum rated:
1. 24 pair:
 - a. Belden 1821R; or

- b. Clark Wire 724; or
 - c. West Penn WP45424.
- 2. 16 pair:
 - a. Belden 1819R; or
 - b. Clark Wire 716; or
 - c. Gepco GA61816GFC; or
 - d. West Penn WP45416.
- 3. 12 pair:
 - a. Belden 9768, or
 - b. Belden 1818R; or
 - c. Clark Wire 712; or
 - d. Gepco GA61812GFC; or
 - e. West Penn D434; or
 - f. West Penn WP45412.
- 4. 8 pair:
 - a. Belden 18710R; or
 - b. Clark Wire 708; or
 - c. Gepco GA61808GFC; or
 - d. West Penn WP4548.
- 5. 6 pair:
 - a. Belden 8778; or
 - b. Belden 1816R; or
 - c. Clark Wire 706; or
 - d. Gepco GA61804GFC; or
 - e. West Penn D432; or
 - f. West Penn WP4546.

6. 4 pair:
 - a. Belden 1815R; or
 - b. Clark Wire 704; or
 - c. Gepco GA61804GFC.
7. 3 pair:
 - a. Belden 8777; or
 - b. West Penn D431.
8. 2 pair:
 - a. Belden 9451D; or
 - b. Clark Wire RS22G2; or
 - c. Gepco D61801EZGF; or
 - d. West Penn D430 or 2452.
- I. 22 AWG MC/P, microphone or line-level multi-conductor cables installed in a return-air plenum (not for interconnection within equipment racks), 22 AWG individually shielded pairs, color coded, PVC jacket:
 1. 12 pair:
 - a. Clark Wire 22EPS12P; or
 - b. Gepco 6612HS
 2. 8 pair:
 - a. Clark Wire 22EPS8P; or
 - b. Gepco 6608HS
 3. 6 pair:
 - a. Belden 6545PA; or
 - b. Clark Wire 22EPS6P; or
 - c. Gepco 6606HS.
 4. 4 pair:
 - a. Clark Wire 22EPS4P; or

- b. Gepco 6604HS.
- 5. 3 pair:
 - a. Belden 6542PA.
- 6. 2 pair:
 - a. Belden 6541PA or 9451DP.
- J. 14 AWG/NP, loudspeaker cable installed in conduit or other non-plenum interior locations:
 - 1. Belden 1309A or 8473; or
 - 2. Belden 5100UE or Gepco SSU14R; or
 - 3. Clark Wire CW1402; or
 - 4. West Penn 226.
- K. 16 AWG/NP, loudspeaker cable installed in conduit or other non-plenum interior locations:
 - 1. Belden 1307A or 8471; or
 - 2. Belden 5200UE or Gepco SSU162R; or
 - 3. Clark Wire CW1602; or
 - 4. West Penn 225.
- L. 18 AWG/NP, loudspeaker cable installed in conduit or other non-plenum interior locations:
 - 1. Belden 9740 or 5300U1; or
 - 2. Belden 5300UE or 8461 or Gepco SSU182R; or
 - 3. Clark Wire 1802; or
 - 4. West Penn 224.
- M. 14 AWG/P, loudspeaker cable installed in a return-air plenum without conduit, plenum rated:
 - 1. Belden 1861A; or
 - 2. Belden 6100UE or Gepco SSU142P; or
 - 3. Clark Wire CW1402P; or
 - 4. West Penn 25226B.
- N. 16 AWG/P, loudspeaker cable installed in a return-air plenum without conduit, plenum rated:

1. Belden 1862A; or
 2. Belden 6200UE or Gepco SSU162P; or
 3. Clark Wire CW1602P; or
 4. West Penn 25225B.
- O. 18 AWG/P, loudspeaker cable installed in a return-air plenum without conduit, plenum rated:
1. Belden 1863A or 6300UE; or
 2. Belden 82740 or Gepco SSU182P; or
 3. Clark Wire CW1802P; or
 4. West Penn 25224B.
- P. RG-58/NP, single 50-ohm coax, installed in conduit or other non-plenum interior locations, not plenum rated:
1. Belden 7806R; or
 2. Clark Wire CV5058; or
 3. West Penn 812.
- Q. RG-58/P, single 50-ohm coax, installed in return-air plenum, plenum rated:
1. Belden 82240 or 88240; or
 2. Clark Wire CV5058P; or
 3. West Penn 25812.
- R. RG-8X/NP, single 50-ohm coax, installed in conduit or other non-plenum interior locations, not plenum rated.
1. Belden 7808R or 9258; or
 2. Clark Wire CV5008X; or
 3. Gepco V5020; or
 4. West Penn 807.
- S. RG-8X/P, single 50-ohm coax, install in return-air plenum, plenum rated:
1. West Penn 25810.

- T. RG-8/U/NP, single 50-ohm coax, installed in conduit or other non-plenum interior locations, not plenum rated:
 - 1. Belden 9913; or
 - 2. Clark Wire RF50LL; or
 - 3. West Penn 810.
- U. RG-8/U/P, single 50-ohm coax, installed in return-air plenum, plenum rated:
 - 1. Belden 89913; or
 - 2. Clark Wire RF50LLP; or
 - 3. West Penn 25812.

2.6 CABLES – FACTORY TERMINATED – INSTALLED

- A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this section does not indicate a requirement for use.
- B. Factory terminated cable assemblies specified in this subsection are only permitted for use within racks or between devices external to racks. Not permitted for use in conduit unless specifically noted as such. Permitted for rack inter-connect when racks are in close proximity (same room) and may pass thru conduit if necessary in this situation. Required for rack intra-connect where applicable.
- C. Factory terminated cable assemblies shall be the minimum length needed to accomplish the connection. Portable cable assemblies are specified in Division 27 Section “Audio Video Systems Equipment” and are required to be furnished in addition to those required for system installation.
- D. All cable assemblies must be factory tested and certified.
- E. Category cabling:
 - 1. Refer to Division 27 Section “Telecommunications Requirements for Audio Video Systems” for product information and additional installation requirements.
- F. DisplayPort, version 1.1a or higher, Acceptable lengths: 1’-25’:
 - 1. Clark Wire DP Series (3’, 6’, 10’, 15’); or
 - 2. Comprehensive DisplayPort Standard Series (3’, 6’, 10’, 15’, 25’); or
 - 3. Extron DisplayPort M-M Series (3’, 6’, 12’, 25’); or
 - 4. Approved Equal.
- G. HDMI Locking Cable, version 1.4 or higher compliant, locking connectors, male HDMI to male HDMI, Acceptable lengths: 1’-25’:

1. Belden HD-800 Series (2', 4', 8', 25'); or
 2. Clark Wire HDMI-L Series (3', 6', 10', 16'); or
 3. Perfect Path 700 Series (2', 4', 8', 16', 25'); or
 4. Approved Equal.
- H. HDMI Fiber Optic Cable, version 1.4 or higher compliant, male HDMI to male HDMI, Acceptable lengths: 25'-328':
1. Celerity DFO Series (35', 40', 50', 60', 80', 100', 160', 200', 300'); or
 2. Liberty DL-HDM-M-***M Series (8m, 10m, 15m, 23m, 30m, 50m, 60m, 100m); or
 3. Cables To Go RapidRun Optical Series (25', 35', 50', 65', 80', 100', 125', 150', 175', 200'); or
 4. Approved Equal.
- I. USB, Type B male (device = square) to Type A male (computer = flat) or Type A male to Type A male USB 2.0 compliant, Acceptable lengths: 1'-25':
1. Comprehensive; or
 2. Extron; or
 3. Approved Equal.

2.7 CONNECTORS

- A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this section does not indicate a requirement for use.
- B. All XLR receptacles located outdoors, in boxes that are located outdoors, in natatoriums, or in areas where moisture or other corrosive materials are present shall have gold plated contact pins.
- C. XLR Cable Connector, cable mounted connector for line-level, microphone level, and intercom circuits:
1. Amphenol AC series; or
 2. Neutrik X-series; or
 3. Switchcraft E Series Q-G.
- D. XLR Panel Connector, panel mounted audio connector for line-level, microphone level, and intercom circuits, color shall match plate color where possible:
1. Amphenol AC "DZ" series; or
 2. Neutrik D-Series; or

3. Switchcraft standard AAA Series Q-G with metal handle.
- E. XLR Combo Connector, female XLR and 1/4" TRS receptacle in one chassis-mount connector:
 1. Neutrik NCJ6FI-S.
- F. 1/4" TRS Cable Connector, three-conductor (Tip Ring Sleeve) connector with a metal barrel and solder lugs:
 1. Amphenol TS3PN; or
 2. Canare F-16; or
 3. Neutrik NP3C; or
 4. Switchcraft 267.
- G. 1/4" TS Cable Connector, two-conductor (Tip Sleeve) connector with a metal barrel and solder lugs:
 1. Amphenol TM2PN; or
 2. Canare F-15 plug; or
 3. Neutrik NP2C plugs; or
 4. Switchcraft 250.
- H. 1/4" TRS Panel Connector, three-conductor (Tip Ring Sleeve) connector with the sleeve contact isolated from the panel or plate to which it is mounted:
 1. Neutrik NJ3FP6C; or
 2. Switchcraft E112BL.
- I. 1/8" TRS Cable Connector, 1/8" (3.5mm) three-conductor mini-plugs which have a metal barrel and solder lugs:
 1. Amphenol KS3P; or
 2. Canare F-12; or
 3. Neutrik NTP3RC; or
 4. Switchcraft 35HDNN plug.
- J. RJ45 Panel (Faceplate) Connector-6, data connector rated for shielded Category 6 cable:
 1. Neutrik etherCON NE8FDY-C6* with SCDX cover

*Division 27 "Telecommunications Requirements for Audio Video Systems" Contractor shall terminate horizontal cable onto etherCON connector installed in custom faceplate.

K. BNC Cable Connector, 75-ohm BNC, compression fitting for coaxial cable furnished:

1. Amphenol 112*** series sized for the application; or
2. Liberty CM-RG-BNC series; or
3. West Penn CN-CS-BNC and CN-FS-BNC series.

L. BNC Panel Connector, 75-ohm BNC, pass-through, D-style mounting:

1. Amphenol AC-BNC-JJA-75T; or
2. Neutrik NBB75DFI; or
3. Approved Equal.

M. Terminator, RF or SDI terminator plug:

1. Extron T-BNC series; or
2. Pomona 3840 series; or
3. Trompeter TNA series.

N. Captive Screw Terminal Block, modular terminal blocks for mounting on DIN rails:

1. Entrelec Screw Clamp series; or
2. Approved Equal.

2.8 EQUIPMENT RACKS

A. Furnish complete equipment racks including all top, bottom, and sides as necessary.

B. Furnish all necessary accessories including ganging hardware, blank plates (to fill all unoccupied space), vent panels (as applicable), shelves, security covers, mounting screws, trim kits, lacing bars, cable management, leveling feet, casters, etc. to provide a complete solution which complies with “best practice” guidelines.

1. Full-solution accessories are not detailed in this specification. They shall be provided as needed and shall be approved by the manufacturer for use with the intended rack series (i.e. Middle Atlantic casters must be used with a Middle Atlantic rack).

C. Furnish all required components for a complete thermal management solution within each location to ensure enclosure interior temperature does not exceed manufacturer’s recommended operating temperatures.

1. Rack fans shall achieve a quiet operating condition, such as the Middle Atlantic QFAN.
2. Thermostatic fan control shall be utilized where appropriate.

- D. Furnish all required components for a complete rack ground isolation solution.
 - 1. Racks shall be isolated from the floor by the use of isolated leveling feet (such as Middle Atlantic LF-ISO) or an isolation pad/system (such as Middle Atlantic ISO-1).
- E. Equipment racks and all associated blank panels located in equipment rooms shall be factory finished semi-gloss black. Equipment racks and associated blank panels located in control booths or other visible locations shall be factory-finished color as selected by the Architect.
- F. Furnish locking storage drawers, hinged security covers, and racks with locking doors all keyed alike. Furnish four keys total.
- G. Equipment rack specification indicates the system basis of design. Verify equipment layout, rack size, and number of equipment racks required for equipment furnished.
- H. Wall Rack – Sectional - XS, wall-mount rack with separate back plane and rack sections, height as required (xx denotes rack height in part number), extra shallow minimum 17" depth:
 - 1. Lowell LWR-xx19 series; or
 - 2. Middle Atlantic Products DWR-xx-17 series; or
 - 3. Chief SWR-xx-17 series.
- I. Wall Rack – Sectional – S, wall-mount rack with separate back plane and rack sections, height as required (xx denotes rack height in part number), shallow minimum 22" depth:
 - 1. Atlas Sound WMAxx-23 series; or
 - 2. Lowell LWR-xx23 series; or
 - 3. Middle Atlantic Products DWR-xx-22 series.
- J. Above Ceiling Rack, 2RU, 25lb capacity, for 2' x 2' suspended ceilings, with smart AC and fan:
 - 1. FSR CB-22S; or
 - 2. Approved equal.

2.9 EQUIPMENT RACK ACCESSORIES

- A. The equipment rack accessories in this section have been approved for use in the project as indicated on the rack elevations or within this section.
- B. Equipment rack accessories located in equipment rooms shall be factory finished semi-gloss black. Equipment rack accessories located in control booths or other visible locations shall be factory-finished color as selected by the Architect.
- C. Logo rack panel, single vertical rack space, labeled with contact information for the contractor and Design Consultant. Panel specified is custom and already has the information for the Design Consultant;

the contractor shall coordinate their logo/information with the panel manufacturer (shop drawing required). One required to be installed at the top of each bank of equipment racks:

1. Liberty Wire and Cable model HEI-RHIM-TEMPLATE.
- D. Equipment rack shelf – 1, utility rack shelf, 1.75" high, minimum 10" deep, color to match adjacent rack-mounting panels:
1. Atlas Sound SH1-10; or
 2. Middle Atlantic U1-RP12; or
 3. Chief UTS-1.

2.10 STORAGE

- A. Lockable Steel Storage Cabinet, 36"W x 18"D x 72"T combination cabinet with 4 half-width adjustable shelves, full length top shelf, and half-width vertical cavity (for microphone stands). Glue and screw a rubber mat to the bottom of the cavity for microphone stands to prevent slippage. Color to match equipment racks if located in the same room, otherwise color as selected by the Architect. Mount cabinet if shown on drawings, otherwise mount as later directed by Owner's Representative. (one cabinet required, four keys required):
1. Globalindustrial.com WB894113 series; or
 2. Lockers.com model 9274 Combination Storage Cabinet; or
 3. Approved Equal.

2.11 STANDBY EQUIPMENT

- A. The following equipment shall be on-hand at the time of system commissioning and system first-use for possible replacement of defective equipment or for field conditions noted. Maintain ownership of this standby equipment. However, if any item of this standby equipment is used to replace defective equipment, the installed item of standby equipment becomes Owner's property. Assume ownership of the defective equipment:
1. Backup software for programmable devices.
 2. Laptop computer for all programmable devices.
 3. Allowances for overnight shipping of critical components should be included and utilized if component failure is essential to Owner's initial operation or first-use requirements.

2.12 AC POWER

- A. General

1. A complete AC power connection solution for each equipment rack and cabinet is required.
 2. Provide spare NEMA 5-15R or 5-20R outlets (single duplex receptacle) for temporary equipment (beyond that required for connected equipment, rack fan, etc.). These outlets shall be fed from an un-switched "Normal" power circuit.
 - a. For racks 16 RU or less: two spare outlets (minimum)
 - b. For racks greater than 16 RU: four spare outlets (minimum)
 3. All power strips shall maintain integrity of system grounding requirements.
 4. All equipment shall be connected such that maximum rated performance can be obtained without exceeding the AC circuit load capacity.
 5. Coordinate with Electrical drawings and Division 26 specifications. Where outlets are provided under this section as a portion of power strips or power distribution units, receptacle types and colors shall match the supplied AC power circuit.
 6. Comply with all NEC requirements, including separation of loads classified as Life Safety from Normal loads via an independent Vertical / Horizontal Power Strip, PDU, and/or UPS.
- B. Uninterruptable Power Supply Requirements
1. UPS shall be provided in quantities as indicated on signal flows and/or rack elevations, and as described for components and equipment within this Section and associated Subsections.
 2. A UPS connected to a Normal power load shall be provided with enough battery capacity to bridge short duration loss of power and brownout events. The intent is to protect and prolong the life of sensitive processor based equipment, reduce power cycle time upon restoration of Normal power, and/or allow the User time to safely shut down components.
 3. A UPS connected to Emergency (NEC Article 700), Legally Required Standby (NEC Article 701), or Optional Standby (NEC Article 702) AC power circuits shall be provided with enough battery capacity to bridge the maximum operation load of the connected equipment during the time from loss of Normal power to load handover to the electrical standby power system (typically generator startup time).
- C. PDU/H: Horizontal Power Strip, single 120V 15A circuit, NEMA 5-15P plug input, minimum eight rear-facing NEMA 5-15R outlets, single rack space (furnish where provided electrical receptacle quantities do not meet system requirements):
1. Middle Atlantic PD-915-PL; or
 2. Tripp Lite PDU1215; or
 3. Approved equal.
- D. UPS-1RU: Uninterruptable Power Supply, single rack space chassis, line interactive, surge suppression, 120V 20A circuit, minimum 750VA load, plug input, minimum four rear-facing NEMA 5-15R outlets:

1. APC Smart-UPS SUA750RM1U; or
2. Eaton 5P750R; or
3. Middle Atlantic UPS-S1000R; or
4. Tripp Lite SmartPro SMART750RM1U; or
5. Approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 PREPARATION

- A. Coordinate locations and sizes of junction boxes, outlets, and conduit with the work of other trades. Field verify compliance with the construction documents.
- B. Carefully inspect areas where equipment will be installed. Notify the Architect of any conditions that would adversely affect the installation and subsequent operation of the system.
 1. Repeat inspection on a regular basis to ensure ongoing work by other trades does not pose a conflict to Contractor's pending work.

3.3 INSTALLATION

- A. General
 1. Contractor shall demonstrate a reasonable standard of care. Installation shall be rendered in a workmanlike manner observing direction set forth herein as well as industry standard best practices.
 2. In addition to any spare cabling shown on drawings, utilize industry best practice to pull additional spare cabling in conduit where logical. Neatly bundle a usable length of cable at each end of each spare circuit. All spare circuits shall be labeled and noted on the field drawings for inclusion into the record drawings.
 3. Install any floor-mounted receptacles so that release buttons (for both receptacles and cable connectors) are easily accessible when cable connectors are installed.
 4. Blank panels and/or vent panels shall be installed in unused rack spaces. Ensure that air flow within the rack is maintained (i.e. cool air can enter the rack and hot air can exit the rack).

5. Equipment racks and other exposed equipment shall be kept covered and protected from airborne contaminants. Clean all equipment racks and the interior rack floor, prior to system commissioning activities.
6. Where the design location requires products, materials, or equipment to be visible to the public, manufacturers logos shall be removed if possible. Unless otherwise directed, neatly remove or logos.
7. AC power switches located on the front panel of equipment mounted in racks shall be covered by a security cover or utilize front panel lockout features. Exclusions from this list are items requiring user interface such as wireless microphone receivers.
8. Furnish all equipment with factory finish where possible using the standard available factory color(s) as selected by the Architect. Notify the Architect regarding color options of relevant equipment prior to ordering equipment from each manufacturer.

B. Installed Systems

1. General

- a. Contractor shall provide installation system, including connection to structure, for all installed components including but not limited to: loudspeakers, video projectors, flat panel displays, projection screens, etc.
- b. Installation system design shall be prepared by the Contractor and include fully dimensioned detail documentation stamped by a structural engineer per submittal requirements in Part 1 of this document.
- c. Installation shall conform to industry best practice standards as set forth in:
 - 1) “Basic Principles for Suspending Loudspeaker Systems” (JBL Professional Technical Note Volume 1, Number 14)
- d. Coordinate with General Contractor any supplemental building structure necessary to facilitate the approved suspension design.
- e. Field verify conditions for compliance with the approved suspension plan prior to installation or material fabrication. Coordinate with other trades as necessary.

2. Loudspeakers

- a. Install loudspeakers so there are no obstructions to loudspeakers' coverage pattern.
- b. Loudspeakers shall be installed such that they do not produce or cause mechanical rattles in the surrounding structure. There shall be no audible vibration or noise caused by improper mechanical installation or defective components.
- c. Paint loudspeaker and/or grille assembly (at discretion of Architect or Consultant) to match surrounding finish. Use primer per manufacturer's recommendations. Do not paint loudspeaker cones or high frequency diaphragms. Materials and labor provided by Contractor.

- d. Provide access to loudspeakers during installation, testing, and commissioning activities. Access includes all necessary resources required to obtain direct physical contact to loudspeakers, including: scaffolding, motorized lift, etc.
- e. Provide ability to reorient loudspeakers in all axes (yaw, pitch, and roll) if so requested by Consultant during system commissioning activities.
 - 1) Do not perform final connections prior to commissioning and acceptance by the Consultant including: permanent cable swage, elimination of wire rope service loop, etc.

C. Video

- 1. Coordinate structural backing required for wall mounted flat panel displays prior to the installation of drywall or other wall materials.
- 2. Neatly dress all cables behind a flat panel display. Cables and connections should not be visible from the viewing locations. Power cables for displays shall not be bundled with signal cables.

D. Grounding

- 1. Each equipment rack within a row of racks and each row of racks within a room shall be electrically bonded to each other. Bonding shall be via copper ground bus. Any bolts shall fasten to unpainted sheet metal.

E. Equipment Power Control

- 1. Low-voltage "ON/OFF" control of system equipment shall be provided via the control system.
- 2. Operation of the following components is required, at a minimum:
 - a. Power amplifiers as indicated in Part 2 requirements
 - b. UPS connected devices where components do not require power under system shutdown
 - c. Components equipped with power state control
- 3. Make all low-voltage connections as required to provide a complete and working control system.
- 4. Refer to drawings for additional low-voltage sequencing system requirements.
- 5. Refer to electrical drawings for AC power information.
- 6. Coordinate with Electrical Contractor as necessary to verify proper circuit assignment and sequencing order.

F. AC Power Sequencing

- 1. Where the Power Sequencer 1RU/SA or Power Sequencer 1RU is used, "ON/OFF" control of AC power shall be by the built-in "ON/OFF" rocker switch at the sequencer front panel.

2. Where a control system is provided, power sequencing shall be a portion of the logic.
3. AC power circuits shall be switched via the sequencer to turn the power amplifiers on last and off first. Delay power amplifier circuits such that they do not all switch at once.
4. UPS and PDU equipment with an IP / LAN connection shall be configured to e-mail up to (3) Owner e-mail accounts for each type of alarm. Also, train Owner on use of web interface and how to update e-mail alarm settings.

3.4 CABLE MANAGEMENT AND TERMINATION

- A. Employ cable management and installation techniques to fulfill ANSI/AVIXA 10:2013, 9.4 (ANS2013-12-20) "Cable Management, Termination, and Labelling Reference Verification Items" as a minimum standard with the additional requirements as described in this paragraph.

B. General

1. Do not violate the minimum cable bend radius as specified by the cable manufacturer.
2. Dress cables so terminations are free from stress due to gravity acting on the cabling. Use cable supports as required depending on the size and stiffness of the cable.
3. Terminate cables with sufficient service loop to allow at least one re-termination without having to open a cable bundle or pathway.
4. All circuits, including various audio signal levels, shall be separated according to function. Where audio and video circuits are installed in conduit or other raceway, separate conduits are required for the various circuit functions.
5. Where circuits are exposed in the equipment racks or large junction or pull boxes, circuits shall be bundled according to function. Refer to "Conduit/Circuit Group Divisions" and "Conduit Routing and Separation" schedules for additional information.
6. All solder connections shall be made with soldering iron and rosin core solder. All solder connections shall be checked for "cold" solder joints.
7. If equipment is removed or replaced for service, ensure the proper cable termination points are apparent when the equipment is re-installed.

C. Equipment Racks

1. Use Velcro tie wraps for dressing cables within the rack(s), hand tightened and spaced at various inconsistent distance intervals.
2. Do not use zip ties for UTP cables or any in-rack cables.
3. When dressing cables within the rack, do not tighten tie wraps so the cable is deformed.

4. Install rack-mounted equipment manufactured without IEC removable power cords so the power cords are dressed using removable fasteners such as Velcro and there are no obstructions to the item being pulled out from the front of the rack. Avoid coiled or bundled cable loops.
5. For rack-mounted equipment manufactured with IEC removable power cords, provide power cord assemblies of the minimum length needed to accomplish connection to the PDU. Avoid excess power cabling including coiled or bundled cable.
6. Factory terminated cable assemblies are only permitted for use within racks, between devices external to racks, as portable equipment, or for use in conduit unless specifically noted as follows:. Permitted for rack inter-connect when racks are in close proximity (same room) and may pass thru conduit if necessary in this situation. Required for rack intra-connect where applicable. Cable assemblies shall be the minimum length needed to accomplish the connection.
7. Install rack equipment to enable repair or replacement without hindrance. If there are obstructions prohibiting the disconnection of terminations on the back side of the technical equipment, there must be sufficient cabling to permit the equipment to be pulled from the front allowing for easy disconnection.

D. Splicing, Paralleling, and Extension

1. Circuits shall not be spliced.
2. Circuits requiring parallel connection as indicated on signal flows shall be extended via approved termination in an appropriately sized junction box and shall conform to the following guidelines:
 - a. Approved connections include DIN mounted terminal blocks as specified in Part 2.
 - b. Field splicing techniques such as wire nuts, “twist and solder”, etc. are not allowed.
 - c. Any circuit requiring parallel connection shall be permanently labelled on every cable as defined herein.
 - d. Care must be taken to maintain appropriate protection and shielding of circuits in order to maintain a fully functional system.
3. Circuits requiring extension (non-data) due to field conditions such as excessive conduit bends, etc., shall be extended via approved termination in an appropriately sized junction box and shall conform to the following guidelines:
 - a. Extension of circuits is to be avoided if at all possible.
 - b. Prior to commencement of work, contact the Design Consultant via documented project communication. Inform the Design Consultant of the circumstances regarding the desired extension. Contractor and Design Consultant will coordinate to determine the most appropriate course of action.
 - c. Approved connections include DIN mounted terminal blocks as specified in Part 2.
 - d. Field splicing techniques such as wire nuts, “twist and solder”, etc. are not allowed.

- e. Any circuit requiring extension shall be permanently labelled on every cable as defined herein.
- f. Care must be taken to maintain appropriate protection and shielding of circuits in order to maintain a fully functional system.

E. Telecommunications Cabling

- 1. Refer to Division 27 Section “Telecommunications Requirements for Audio Video Systems” for all work associated with data-related cabling including Category cabling.
- 2. All data-related cabling entering a rack shall be terminated to a Data Patch Panel. Rack inter- and intra-connect cabling utilizing factory-terminated cable assemblies are not required to pass thru a Data Patch Panel.

F. Microphone/Line Level Audio

- 1. Audio circuit termination shall observe the methods set forth in “Sound System Interconnection” RaneNote 110, © 2011 by Rane Corporation. This reference document may be obtained at: http://www.rane.com/pdf/ranenotes/Sound_System_Interconnection.pdf
- 2. Key methods include, but are not limited to the following:
 - a. All audio circuits shall be balanced two-wire circuits, with a separate grounding shield conductor, unless noted otherwise. All circuits shall have either the red or white wires as the "high" or "+" side of the line and connect to pin 2 of microphone-type XLR audio connectors and the tip of 3-conductor phone connectors. The black wire of the two-wire circuit shall be the "low" or "-" side of the line and connect to pin 3 of microphone connectors and the ring of 3-conductor phone connectors. The shield conductor shall connect to pin 1 of microphone connectors or to the sleeve of phone connectors.
 - b. Shield conductors shall be connected at each end of each wire to the pin 1 of each XLR, shield connection for each electronic device, etc. No shield wires shall be left unconnected except where noted on the drawings, nor shall any shield come in contact with conduit, pull boxes, or other building steel. Audio line-level circuit shield wires shall be grounded to rack sheet metal only via rack-mounted equipment. Shields shall be electrically isolated in multi-conductor cables. Shields for audio line-level circuits connected to audio transformers shall be connected to transformer electro-static shields and case ground.
 - c. In the case of an unbalanced source feeding into a balanced input and the cable run is short (i.e. less than fifteen feet), connect the signal connection of the unbalanced connector to the “high” side of the balanced input. Connect the “ground” connection of the unbalanced line to the “low” side of the balanced connector. Connect the cable shield to the shield connection of the balanced input but do not connect it to the unbalanced connector. If the cable run is longer than fifteen feet, balance the line at the unbalanced source using specified balancing devices.
 - d. In the case of a balanced source feeding into an unbalanced input and the cable run is short (i.e. less than fifteen feet), connect the “high” side of the balanced output to the signal input of the unbalanced connection. Connect the “shield” of the balanced connection to the

“ground” of the unbalanced connection. Leave the “low” side of the balanced output floating.

G. Loudspeaker Level Audio

1. Loudspeakers in the same acoustic space shall all be wired to produce consistent polarity with a mono input signal. They shall also be polarized such that a positive acoustic pressure on a microphone results in a positive acoustic pressure at all loudspeakers.

H. Video

1. Compression fittings shall be used for all BNC and F connector terminations.
2. Terminate all unused RF and SDI outputs with impedance matching terminators.
3. Neatly dress all cables behind a flat panel display. Cables and connections should not be visible from the viewing locations. Power cables for displays shall not be bundled with signal cables.
4. For fixed projector or pole mounted flat panel display installations, signal cables shall be routed within the mounted pipe. Signal cables shall not be tied to the outside of the pipe. Provide cabling of appropriate distance to minimize excess cable at device. Bundle excess cable above the ceiling, not at the device.

3.5 LABELING

- A. Adhere to AVIXA F501.01:2015 “Cable Labeling for Audiovisual Systems” as a minimum standard with additional requirements as described in this paragraph.
- B. Refer to Division 27 Section “Telecommunications Requirements for Audio Video Systems” for all labeling requirements associated with data-related cabling including Category and Fiber Optic cabling.
- C. Develop and utilize a consistent numbering scheme across the entire project. Utilize system names and building references where applicable, such as the rack number or rack room in a distributed system. All labels for input/output plates and control panels shall be consistent with the final room numbering for the facility.
- D. Adhere to the labeling standard across all platforms, including within the DSP programming.
- E. Refer to general notes, the signal flows, and panel and plate details for expected labeling scheme of system equipment and components. Comply with any specific color coding as described.
- F. All equipment in equipment racks shall be labeled front and rear for ease of identification. Labels shall be of a contrasting color with that of equipment color to promote visibility.
- G. Within each rack and at other remote locations for technical system equipment, label all associated AC power receptacles reflecting the appropriate circuit breaker. Ensure that the circuit breakers are labeled as to the rack or remote equipment location.
- H. Document the labeling standard for inclusion in the Operation and Maintenance Data.

- I. Document all labels for the Record Drawings.
- J. Pre-approved labelling systems include:
 - 1. Brother P-touch EDGE with HGeS2***PK labels; or
 - 2. Brady Equipment Identification Labels.

3.6 SYSTEM CONFIGURATION

A. Coordination

- 1. Coordinate and take responsibility for the approval of all system configuration components as described in this paragraph.
- 2. Coordinate all aspects of the technical system network, including configuration and connection with to the Owner's LAN. Utilize Owner's designated configuration style, standards, and security requirements.

B. Software

- 1. Furnish, install, and configure the most recent approved, non-beta, software for each device or system.
- 2. Provide software as identified in other areas of these specifications or on the drawings.
- 3. Provide software not specifically identified but required to allow for system operation and/or to allow for more efficient system configuration, setup, and operation.

C. Firmware

- 1. Ensure the firmware for each device is the most recent manufacturer approved version and is installed and operational.

D. Operating Systems

- 1. Gain approval of the operating system version and type from the Owner's IT representative and associated equipment manufacturer(s).
- 2. Ensure the operating system for each device is the most recent, installed, and fully operational.
- 3. Ensure the latest security patches are installed.

E. Network Configuration

- 1. All technical system devices with an Ethernet port shall be connected to the associated network.
- 2. Secure the entire network, documenting all passwords. Comply with the Owner's IT representative's requirements with respect to password selection and network security implementation.

F. Network Documentation

1. Document the IP and MAC addresses of all IP capable equipment for inclusion with the Operation & Maintenance Manuals.

3.7 CONTRACTOR'S TESTING, ADJUSTMENT, AND SUBMITTAL REQUIREMENTS

- A. At the completion of the installation, perform the following tests on the system to ensure proper installation and operation. The technical system shall be fully tested with all equipment on site, installed, connected, and fully operational.

B. General

1. Utilize the technical support services offered by the manufacturers of the various technical system components to ensure optimum performance.
2. All test equipment used for these tests shall be on site during the system commissioning activities should verification of submitted measurements be required.
3. Ensure that all equipment is on the job-site and fully operational. This includes portable (not installed) items and other loose equipment. Remove all devices from shipping or packaging containers, ready for use, and place in equipment storage cabinet.
4. The functional tests shall include operational tests of all program source equipment, microphone system, system inputs and outputs, all patch panel receptacles, video routing, video distribution, operational controls, AC power sequencing, operation of software, and all system electronics. Functional tests include examination for hum, buzz, hiss, ghosts, hum bars, oscillation, thumps, unintended reception of other signals such as AM or FM radio, TV, CB, ham radio, cell phones, or any other unwanted signals through the system.
5. Ensure all inputs and outputs are wired to the appropriate devices per construction documents.
6. Verify system startup and shutdown operates in the proper sequence.
 - a. System head end components shall be energized at the beginning of the startup sequence in an appropriate order to guarantee proper communication will associated devices.
 - b. Loudspeaker power amplifiers shall be energized at the end of the sequence in order to eliminate unwanted transients being reproduced through system loudspeakers.
 - c. System shutdown sequence shall be in reverse order.
7. Where a system computer is furnished, load and configure all necessary control software. Examples include but are not limited to the following as applicable: wireless microphone management, amplification management, projector/display management, audio console configuration/control, DSP configuration/management, and active loudspeaker management.
8. Where audio or video digital signal transport is required, ensure all network setup is complete including the installation and licensing of network management application software.

C. Required testing equipment

1. Certain systems/subsystems require testing and documentation via approved test equipment.
 - a. Systems requiring testing via approved devices will be identified below.
 - b. Required test devices will be listed in related sections.
 - c. Provide unified testing results of like systems. Describe testing procedure including all test equipment used.
 - d. Provide original results from testing equipment (as applicable).
2. Failure to submit proof of testing via approved devices will result in delayed commissioning and final approval by the Consultant.
3. Failure to submit testing documentation produced by approved devices will result in delayed commissioning and final approval by the Consultant.
4. Contractors unable to provide required test equipment shall employ the services, at their own expense, of a certified subcontractor to assist in testing and documentation.

D. Audio System

1. Electronics
 - a. Test all system audio electronic components for uniform frequency response from input to power amplifier output.
 - b. Supply pink noise to a single system input.
 - c. With all signal processing bypassed (equalization band pass filters, crossovers, dynamics, etc.), independently route signal through audio console, DSP, and any other system processing components to an amplifier output.

With speaker load disconnected, measure the signal response of the selected amplifier output (to obtain viable measurement results, ensure output level is set to match the measurement device via attenuation of signal or insertion of speaker level to line level attenuator).

- d. Verify the measured response is uniform and matches the reference input signal within $\pm 1\text{dB}$ from 30 Hz to 18 kHz.
 - 1) Required test equipment - Signal Generation:
 - a) Terrasonde/Sencore Audio-Toolbox; or
 - b) Japan Audio Society CD-1 test compact disc
 - c) NTI Minirator MR-PRO

- 2) Required test equipment – Measurement Device:

- a) Rational Acoustics SMAART system v7 or later; or
 - b) NTI Audio XL2 Analyzer; or
 - c) Studio Six Digital Audio Tools RTA or FFT Module, with
 - i) Studio Six Digital iAudioInterface 2
- e. Repeat measurement for each amplifier output channel.
- 2. Assistive Listening System
 - a. Setup and configure the assistive listening system. Verify proper input signal level.
 - b. Walk the entire coverage area using speech as the program material to verify signal performance.
 - c. Set all receivers to match the selected transmit channel(s).
- 3. Microphone/Line Level
 - a. Verify that all microphone and line level cabling and connectors are installed with Pins 1, 2, and 3 wired properly and there are no shorts to ground. Ensure proper polarity.
 - b. Verify that all microphone connectors, extension cables, and microphones are wired properly and in polarity.
 - c. Required test equipment:
 - 1) Alphonson ACT-100 Remote Tester; or
 - 2) NTI Minirator MR-PRO with Cable Test Adapter
 - 3) A microphone is NOT an acceptable measurement device for cable tests.
- 4. Loudspeaker Level
 - a. Measure and record the impedance of all loudspeaker circuits at the output of each amplifier. During this process, also check each loudspeaker circuit for shorts to ground.
 - b. Required test equipment:
 - a) Dayton Audio DATS; or
 - b) NTI Minirator MR-PRO; or
 - c) Sennheiser ZP-3; or
 - d) Terrasonde/Sencore Audio Toolbox

- 2) Unacceptable measurement devices for loudspeaker impedance include the following:
 - a) Digital Multimeter (DMM); or
 - b) TOA ZM-104; or
 - c) TOA ZM-104A
5. Loudspeaker Band Pass/Amplifier Assignment Confirmation
 - a. For full range loudspeakers, apply full spectrum pink noise at sufficient level in order to:
 - 1) Verify subjectively that each loudspeaker is emitting full spectrum signal (both woofer and tweeter/horn are operating)
 - 2) Confirm each loudspeaker is connected to the proper amplifier chassis and output channel.
 - 3) Verify proper phase of each loudspeaker.
 - 4) Required test equipment
 - a) Galaxy Audio CPTS Cricket Polarity Tester; or
 - b) NTI Audio MR-PRO generator with XL2 Analyzer; or
 - c) Studio Six Digital Audio Tools Speaker Polarity Module; with
 - i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or
 - ii) Studio Six Digital iPrecisionMic; or
 - iii) Studio Six Digital iTestMic; or
 - d) Studio Six Digital Speaker Pop; with
 - i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or
 - ii) Studio Six Digital iPrecisionMic; or
 - iii) Studio Six Digital iTestMic
 - b. For loudspeakers with multiple band pass sections (bi-amp, tri-amp, etc.), apply appropriately band-limited pink noise at sufficient level to each device or band pass (i.e. high frequency section, mid frequency section, low frequency section):
 - 1) Verify subjectively that each loudspeaker is emitting appropriately band-passed spectrum signal.

- 2) Confirm each band pass is connected to the proper amplifier chassis and output channel.
- 3) Verify phase of each band pass
- 4) Required test equipment
 - a) Galaxy Audio CPTS Cricket Polarity Tester; or
 - b) NTI Audio MR-PRO generator with XL2 Analyzer; or
 - c) Studio Six Digital Audio Tools Speaker Polarity Module; with
 - i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or
 - ii) Studio Six Digital iPrecisionMic; or
 - iii) Studio Six Digital iTestMic; or
 - d) Studio Six Digital Speaker Pop; with
 - i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or
 - ii) Studio Six Digital iPrecisionMic; or
 - iii) Studio Six Digital iTestMic

6. Loudspeaker Rattle

- a. Verify each loudspeaker is connected to the respective power amplifier and test each loudspeaker throughout its usable frequency range using 1/3-octave bands of pink noise to ensure loudspeaker does not rattle.
- b. Required 1/3-octave band pink noise sources and test equipment include:
 - 1) Terrasonde/Sencore Audio-Toolbox; or
 - 2) Japan Audio Society CD-1 test compact disc
 - 3) NTI Minirator MR-PRO

7. Loudspeaker Equalization

- a. Adjust the frequency response for all loudspeakers to produce a natural, full-range sound.

8. Wireless Microphones

- a. Setup and configure each wireless microphone system using the software provided by the manufacturer of the wireless microphone system. The following tasks are required:

- 1) Utilize wireless microphone management system if applicable, e.g., Shure Wireless Workbench, to perform an RF spectrum sweep.
- 2) Perform frequency coordination with Owner. Take into account existing wireless microphone system(s).
- 3) Calculate spare RF channels (based on 5% of the total wireless system channels).
- 4) Perform frequency assignment of all transmitters/receivers per the results of the frequency coordination and RF spectrum sweep.
- 5) Verify all receivers are set to maximum line level audio output.
- 6) Set all handheld wireless transmitter microphone sensitivity settings to allow high level voice output without AF over modulation. All transmitters should be set the same.
- 7) Set all body pack wireless transmitter microphone sensitivity settings to allow high level voice output without AF over modulation. All transmitters should be set the same.
- 8) Using subjective listening, adjust the body pack settings to match the audio level of the handheld transmitters.
- 9) Walk the entire performance coverage area using speech as the program material to verify signal performance. Utilize wireless microphone management system if applicable, e.g., Shure Wireless Workbench, to perform a QOS test.
- 10) Document wireless microphone frequency assignments including coordinated spare channels.

9. Uniformity of Coverage

- a. Perform audio system verification per ANSI/AVIXA 1M-2009 for all ancillary audio systems, e.g., lobby, restroom, concourse, club, board/meeting rooms, etc. Document per guidelines set forth in the standard.
- b. Required test equipment includes:
 - 1) Required test equipment - Signal Generation:
 - a) Terrasound/Sencore Audio-Toolbox; or
 - b) Japan Audio Society CD-1 test compact disc
 - c) NTI Minirator MR-PRO
 - 2) Required test equipment – Measurement Device:
 - a) Rational Acoustics SMAART system v7 or later; or

- b) NTI Audio XL2 Analyzer; or
 - c) Studio Six Digital Audio Tools RTA or FFT Module, with
 - i) Studio Six Digital iAudioInterface 2
 - c. Provide documentation with preliminary test results.
- E. Video System
 - 1. Verify that all coax video cables pass a DC continuity cable test and contain no electrical shorts. Required test equipment includes:
 - a. Fluke MicroScanner2; or
 - b. Test-Um CX200; or
 - c. Triplet 8-Way WireMaster Coax
 - 2. Verify that all coax video cables pass a frequency sweep test for the bandwidth of intended use. Required test equipment includes:
 - a. Tektronix RSA5000; or
 - b. Rhode & Schwarz FPC1500; or
 - c. Keysight Technology N9340B
 - 3. Verify that all video systems utilizing DVI cabling are tested to confirm the signal path passes full system bandwidth, full system resolution, HDCP as applicable, correct color space and bit depth, and correct frame rate. Required test equipment includes:
 - a. Murideo Fox & Hound A/V Testing and Troubleshooting Kit; or
 - b. Murideo Fresco Field Test Suite; or
 - a. Proton-LVDS Video Generator Analyzer; or
 - b. Purelink HDG 2.0
 - 4. Verify that all video systems utilizing HDMI or DisplayPort cabling are tested to confirm the signal path passes full system bandwidth, full system resolution, HDCP, correct color space and bit depth, correct frame rate, HDR signal and metadata as applicable, and audio as applicable. Required test equipment includes:
 - a. Murideo Fox & Hound A/V Testing and Troubleshooting Kit; or
 - b. Murideo Fresco Field Test Suite; or
 - c. Quantum Data QD780C; or

- d. Purelink HDG 2.0; or
- e. Hall Research PGA-VHD; or
- 5. Setup and calibrate each visual display using current edition of Spears & Munsil High Definition Benchmark Disc. Perform calibration with environmental lighting set to level representative of the system while in use. Verify for each source and variety of resolutions. For projector/screen combinations, the screen drop shall be set to maximize observation from all seats and the image shall fill the available space on the screen.
- 6. Calibrate each video image using a repeatable, calibrated system. Provide documentation for each calibrated image. Results shall also become a part of the Operation/maintenance manuals. Required test equipment:
 - a. Most recent version of SpectraCal CalMAN Ultimate software running on Contractor-provided laptop which exceeds the minimum requirements stipulated by SpectraCal.
 - 1) Supported Meters: as recommended by SpectraCal
 - 2) Supported Pattern Sources: as recommended by SpectraCal; or
 - f. Datacolor Spyder5ELITE Display Calibration; or
 - g. X-Rite ColorMunki Display
- F. Control System
 - 1. Verify performance of the Control System including the operation of all control features.
- G. Adjustment
 - 1. Repair or replace any defects or malfunctions found prior to the commencement of commissioning activities by the Design Consultant.
- H. Testing Documentation Submittal
 - 1. Document the results of all tests and compile into a complete Testing Documentation submittal with the following items:
 - a. Results of the tests detailed herein; and
 - b. Documentation of changes to the systems as a result of any project Change Order, ASI, field directive, Owner direction or the Testing and Adjustment process.
 - c. Digital photographs of primary systems, sub-systems and components; and
 - d. Written notice to the Design Consultant that the system(s) are ready for commissioning.
 - 2. Include the approved Testing Documentation package in the Operation and Maintenance Data package.

3. Modify the Record Drawings to include any changes as a result of the Adjustment process.
- I. Contact the Design Consultant should problems or concerns arise during the testing activities.
- J. Transmit the Testing Documentation submittal to the Design Consultant in a timely fashion to allow the Consultant appropriate time for review and comment prior to final commissioning. The Consultant cannot visit the site or begin the commissioning phase until the submittal has been approved.
- K. Should the Design Consultant be required to invest time performing some or all of the tests, the Contractor will compensate the Design Consultant for all associated costs.

3.8 COMMISSIONING

- A. After completion of the system installation and after the preliminary tests and adjustments are complete, the contractor in conjunction with the Design Consultant shall perform on-site commissioning of the technical system. This process will include, but not be limited to the following, as applicable:
 1. Random verification of contractor tests;
 2. System check-out;
 3. Observation of the technical system's audio frequency response to the facility's acoustical environment;
 4. Observation of video system to verify proper image display;
 5. Function and operability of the control system.
- B. Provide the services of the designated supervisor and any other technicians who are familiar with the system, for approximately two ten-hour days. Additional time may be required due to Alternates accepted by the Owner's Representative, or due to Addenda or Change Orders (if any) which modify the scope of work. The supervisor shall provide personal assistance during these activities. This time period does not include time for correcting wiring errors, equipment malfunctions, or problems related to the installation of the technical system. This work could occur at any time day, night, weekends, or holidays without additional claims for expense.
- C. At the discretion of the Design Consultant, the Contractor shall participate in the control and adjustment of computer controlled systems including but not limited to the following systems: Main control (Crestron/AMX), DSP, wireless microphone, amplifier, active loudspeaker, etc.
- D. At the completion of the final commissioning period, the Contractor shall compile all system configuration settings (files) with copies as required for inclusion in the O&M Manuals described later in these specifications.
- E. In addition, provide the following: hand and power tools appropriate for the type of installation, ladders, lifts, and/or scaffolding as required to reach all high-mounted devices, spare wire and cable of the types used in the installation, selection of wiring fasteners used in the installation, complete set of the most recent reviewed shop drawings, complete set of all manufacturers' original installation/operation/maintenance manuals, and specific test equipment used during the preliminary testing activities.

- F. After the technical system is operational, the Contractor shall provide verbal instruction to designated Owner's Representative as to proper methods of system operation. Video record the instruction class and provide the recording in a usable digital format to the Owner's Representative.
- G. Provide operational assistance for the first major use of the completed system as directed by the Owner's Representative, including being present for: one prior rehearsal associated with the event (if applicable); a technical-check immediately prior to the event; and the event itself.

3.9 OPERATION AND MAINTENANCE DATA

- A. At the completion of the project, compile thorough copies of the Operation and Maintenance Data per Division 27 Section "General Communications Requirements".
- B. Include ANSI E1.47-2017 (Entertainment Technology – Recommended Guidelines for Entertainment Rigging System Inspections) within the O&M data.

3.10 WARRANTY CHECK

- A. Visit the job two weeks prior to the end of the warranty period to check all equipment for proper system operation. Any defective equipment found shall be replaced or repaired under the terms of the system warranty.
- B. Refer to General Conditions for additional requirements.
- C. Update Record Drawings and Operation and Maintenance Data to reflect work done during Warranty period.

END OF SECTION 274100

SECTION 274110 - TELECOMMUNICATIONS REQUIREMENTS FOR AUDIO VIDEO SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. Provide a Telecommunications Structured Cabling System to support a complete and functioning Audio Video System. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, and transport to provide the following:
 - 1. Shielded Category 6 Horizontal Cabling
 - 2. Category 6 Faceplates & Shielded Connectors
 - 3. Modular Category 6 Patch Panels
 - 4. Shielded Category 6 Patch Cables
 - 5. Category 6 Horizontal Cabling
 - 6. Category 6 Faceplates & Connectors
 - 7. Category 6 Patch Cables
 - 8. Category 3 Horizontal Cabling
 - 9. Category 3 Faceplates & Connectors
 - 10. Category 3 Patch Cables
- B. All Category components provided under this section shall comply with Warranty requirements as defined within this section and shall be installed and tested by a certified contractor of the warranty provider. Refer to the Quality Assurance and Warranty paragraphs of this specification for more information on this requirement.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions, requirements, and recommendations in Division 27 Section "General Communications Requirements"
- B. Work under this section shall follow Division 27 Section "Common Work Results for Communications" for general pathway, firestopping, access panel, identification, and other requirements.
- C. Refer to Division 27 "Audio Video Systems" and related sections and drawings for additional requirements and coordination items. Coordinate all work with Division 27 "Audio Video Systems" Contractor.

1.3 CODES, STANDARDS, AND GUIDELINES

- A. In addition to all applicable codes, standards, and guidelines listed in Division 27 Sections “General Communications Requirements” and “Audio Video Systems”, follow the most recent editions of the following:
1. NFPA 70 – National Electrical Code (NEC)
 2. IEEE National Electrical Safety Code (NESC)
 3. ANSI/EIA/TIA 455 50B, Light Launch Conditions For Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements
 4. ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR.
 5. ANSI/TIA/EIA 455 60A, Measurement of Fiber or Cable Length Using an OTDR.
 6. ANSI/TIA/EIA 455 61A, Measurement of Fiber or Cable Attenuation Using an OTDR.
 7. ANSI/TIA/EIA 526 7, Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant.
 8. ANSI/TIA 526 14 B, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; IEC 61280-4-1 edition 2, Fibre-Optic Communications Subsystem Test Procedure- Part 4-1: Installed cable plant- Multimode attenuation measurement.
 9. TIA-TSB-140 – Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems
 10. ANSI/TIA-568-C.O - Generic Telecommunications Cabling for Customer Premises
 11. ANSI/TIA-568-C.1 - Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
 12. ANSI/TIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards
 13. ANSI/TIA-568-C.3 - Optical Fiber Cabling Components Standards
 14. ANSI TIA-569-C – Commercial Building Standard for Telecommunications Pathways and Spaces
 15. ANSI TIA-606-B – Administration Standard for Commercial Telecommunications Infrastructure
 16. ANSI Z136.2, ANS For Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources
 17. BICSI - Telecommunications Distribution Methods Manual
 18. BICSI – Information Technology Systems Installation Methods Manual

1.4 DEFINITIONS

- A. Contractor – in regards to this section only, the contractor responsible for providing a complete Telecommunications Structured Cabling System for Audio Video Systems. This contractor shall be a certified contractor of the manufacturer providing the Advanced System Warranty. Where the Contractor of Division 27 Section “Audio Video Systems” does not meet this requirement, they shall engage the services of a subcontractor who meets the requirements of this section.
- B. Direct Attach Method – as defined in ANSI/BICSI 005-2013, the horizontal cabling on the remote device end directly attaching (or connecting) to the device through a connectorized cable or hard-wired termination, eliminating the workstation outlet, jack and equipment cord.
- C. Horizontal Cabling
 - 1. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located at the equipment rack. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
 - a. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector
 - b. Bridged taps and splices shall not be installed in the horizontal cabling
 - c. Splitters shall not be installed as part of the optical fiber cabling
 - 2. The maximum allowable horizontal cable length for Category copper cable is 295 feet (90 meters), which includes total cable length (including vertical routing and slack). Horizontal cables longer than 295 feet shall be optical fiber.
- D. Structured Cabling / Telecommunications System – a fully-functional passive telecommunications system (infrastructure), that includes permanently installed category copper and fiber optic cable terminated onto a patch panel or outlet.
- E. Technical System Ground – the isolated ground system provided specifically for the Technical (AV) System, as specified in Division 27 section “Audio Video Systems”.
- F. Wet Location - as defined in the NEC, installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather

1.5 QUALITY ASSURANCE

- A. Contractor Qualifications
- B. Personnel Qualifications
 - 1. The person(s) conducting the testing for all Telecommunications cabling shall be a current BICSI Certified Level II Commercial Installer or higher.

- a. Additionally, persons conducting the testing for all fiber optic cabling shall have successfully attended an appropriate training program which includes testing with an OLTS and OTDR and have obtained a certificate as proof thereof. The certified training program shall be:
 - 1) BICSI ITS Installer 2 Optical Fiber
 - 2) Or approved equal
 - b. Submit certificates with pre-construction submittals.
2. Any additional personnel that will be physically installing any part of the Telecommunications Infrastructure covered by this Section shall, at a minimum, be a BICSI Certified Level 1 Commercial Installer in good standing or have equivalent manufacturer training.
 3. These requirements are provided as a minimum level of qualification. Any additional or more stringent requirements by the specific manufacturer chosen to provide the proper level or term of warranty as specified in this division shall be met.
 4. Alternate qualifications may be considered if requested alternates are provided in accordance with the Substitution instructions in Division 27 Section "General Communications Requirements".

1.6 SUBMITTALS

- A. Follow the requirements for submittals in Division 27 Sections "General Communications Requirements" and "Audio Video Systems".
- B. Pre-construction - Follow exact Division 27 Section "Audio Video System" submittal requirements, with additional requirements as noted:
 1. Manufacturers' Cut-sheets – Additional requirements as follows:
 - a. Product data on cabling shall contain the following:
 - 1) Manufacturers name and logo
 - 2) Cable outside diameter
 - 3) Number of conductors/strands in each cable
 - 4) Gauge or strand thickness
 - 5) Minimum transmission performance rating
 - 6) Cable jacket material and rating
 - 7) Maximum pulling tension
 - 8) Jacket/Sheath color

- 9) Minimum bend radius
 - a) During installation and post installation, if different
- b. Product data on faceplates, modules, connectors, patch panels, and enclosures shall contain the following:
 - 1) Manufacturers name and logo
 - 2) Material type
 - 3) Performance rating
 - 4) Physical Dimensions
 - 5) Color
- 2. Shop Drawings
 - a. Scaled layout drawings showing the routing (and support method) of all cabling, and the locations where patch panels, Telecommunications outlets, cable types, cable jacket listing information, firestop locations (with quantity and NRTL system number identified), and fiber optic termination panels are to be installed.
 - 1) Each individual outlet on the drawings shall have proposed outlet identification indicated.
 - b. Scaled enlarged plan and rack elevation drawings showing the locations of patch panels and Rack-Mount Enclosures.
 - c. Unless otherwise required by these specifications, it is permissible to show Work in this section on Division 27 “Audio Video Systems” shop drawings.
- 3. Warranty Information
 - a. Subject to Warranty paragraph, provide sample warranty certificate for the Warranty, indicating manufacturer and their terms/conditions
 - b. Proof that Contractor is certified with the manufacturer
- C. Project Completion - Follow exact Division 27 Section “Audio Video Systems” submittal requirements, with additional requirements as noted:
 - 1. As part of Division 27 Audio Video Systems – Operation & Maintenance Data submittal, also include the following documentation:
 - a. Warranty Certificates (if applicable)
 - b. Cable routing and Outlet locations identified on Audio Video Systems Final Record Drawings, in searchable Acrobat PDF format (so that Work Area Outlet identifiers can be searched for)

- c. Test Results, in PDF, spreadsheet and original test equipment format
- d. Delivery confirmation of spare Patch Cables delivered to Owner
 - 1) Refer to Division 27 “Audio Video Systems” and herein for quantities

1.7 COORDINATION

- A. Review pathways and other Work, as installed per Division 27 section “Common Work Results for Communications”, prior to performing any Work under this section for conformance to all referenced codes, standards, and guidelines.
 - 1. While Division 27 section “Common Work Results for Communications” is being installed, the Project Manager of this section and the Project Manager of Division 27 “Audio Video Systems” contractor shall make weekly inspections and report any issues to the Prime Contractor for correction prior to installation of any cabling.
 - a. Example – Conduit for Category 6 data outlets shall not contain more than two 90 degree bends between pull points.
- B. For projects with other Division 27 telecommunications work, coordinate with Division 27 Telecommunications Contractor(s) prior to bid – similar products shall be by the same manufacturer.
 - 1. This includes:
 - a. Horizontal and backbone cabling
 - b. Copper connectivity
- C. Coordinate with Division 27 “Audio Video Systems” contractor for all Work in AV equipment racks.

1.8 WARRANTY

- A. The Telecommunications Structured Cabling System (as specified in this Section) requires a standard one-year Warranty. An Advanced System Warranty (as often specified as a portion of a cabling system and typically 20-years in length) is not required. Contractor shall submit product cut-sheets indicating product meets one-year minimum warranty period. Warranty certificates are not required. Comply with Quality Assurance and all testing requirements.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL REQUIREMENTS

- A. All cabling shall be from a single manufacturer.
- B. All connectivity shall be from a single manufacturer.

1. Exception: Certain broadcast and faceplate connections/components as specified.

2.2 SHIELDED CATEGORY 6 HORIZONTAL CABLING

- A. All products in this category shall be from a single reputable manufacturer and comply with Coordination and Warranty requirements per Part 1 of this Section unless otherwise noted.

- B. Horizontal cables for dry environments

1. Requirements

- a. Minimum performance specifications: Cable shall meet requirements for Category 6 of TIA-568-C.
- b. Aluminum Foil Tape Shield (F/UTP)
- c. Four pairs of 23 AWG copper conductors with drain wire
- d. Cable jacket color(s) shall be
 - 1) Purple
- e. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name
 - 2) Copper Conductor Gauge
 - 3) Pair Count
 - 4) UL and CSA listing
 - 5) Manufacturer's trade mark
 - 6) Category rating
 - 7) Sequential distance markings, in one foot increments
- f. Individually insulated conductors under a common sheath
- g. Where all cables are to be installed in conduit from outlet box to AV Equipment Rack, cable shall be riser (CMR or MPR) rated. Where any portion of any cable is routed in an air plenum space, cable shall be plenum (CMP) rated.

2. Manufacturer shall be:

- a. From the following list, subject to Coordination and Warranty requirements:
 - 1) Superior Essex CAT 6+ ScTP

- 2) [Belden DataTwist 2400
- 3) Berk-Tek LANMARK-6 FTP
- 4) Hitachi Shielded Category 6 Cable]
- 5) Hubbell Speedchannel FTP Cable, Category 6
- 6) Mohawk Category 6 F/UTP
- 7) Panduit TX6000 Shielded Copper Cable

C. Horizontal cables for wet environments in ducts/conduits

1. Requirements

- a. To be used for pathways in or below slab-on-grade, or where any part of pathway is external to the building or in a Wet or Damp Location (as defined by the NEC).
 - 1) Pathway shall enter the building (where it stubs up out of the slab) in the AV Equipment Room, or within 50' of AV Equipment Room. Coordinate this requirement with Division 27 section "Common Work Results for Communications".
- b. Suitable to be in contact with standing water.
- c. Cable construction shall be consistent with manufacturer's specifications to comply with Warranty requirements.
- d. Minimum performance specifications: Cable shall meet requirements for Category 6 of TIA-568-C.
- e. Four pairs of 23 AWG solid copper conductors
- f. Aluminum Tape Shield (F/UTP)
- g. Cable shall be wet-rated / OSP-rated.
 - 1) And shall transition to a listed cable (plenum or riser rated as appropriate) where it enters the building.
 - 2) This transition is not needed if the conduit stubs up directly into the Communications Room.
- h. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name
 - 2) Copper Conductor Gauge
 - 3) Pair Count

- 4) UL and CSA listing
- 5) Manufacturer's trade mark
- 6) Category rating
- 7) Sequential distance markings, in one foot increments

2. Manufacturer shall be:

a. From the following list, subject to Coordination and Warranty requirements:

- 1) Superior Essex OSP Broadband Category 6
- 2) Or Approved Equivalent

2.3 CATEGORY 6 HORIZONTAL CABLING

A. All products in this category shall be from a single reputable manufacturer and comply with Coordination and Warranty requirements per Part 1 of this Section unless otherwise noted.

B. Horizontal cables for dry environments

1. Requirements

- a. Minimum performance specifications: Cable shall meet requirements for Category 6 of TIA-568-C.
- b. Four pairs of 23 AWG copper conductors
- c. Cable jacket color(s) shall be
 - 1) Purple
- d. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name
 - 2) Copper Conductor Gauge
 - 3) Pair Count
 - 4) UL and CSA listing
 - 5) Manufacturer's trade mark
 - 6) Category rating
 - 7) Sequential distance markings, in one foot increments

- e. Individually insulated conductors under a common sheath
 - f. Where all cables are to be installed in conduit from outlet box to AV Equipment Rack, cable shall be riser (CMR or MPR) rated. Where any portion of any cable is routed in an air plenum space, cable shall be plenum (CMP) rated.
2. Manufacturer shall be:
- a. From the following list, subject to Coordination and Warranty requirements:
 - 1) Superior Essex CAT 6+
 - 2) Belden DataTwist 2400
 - 3) Berk-Tek LANMARK-6
 - 4) Hitachi Category 6 Cable
 - 5) Hubbell Speedchannel Cable, Category 6
 - 6) Mohawk Category 6
 - 7) Panduit TX6000 Copper Cable
- C. Horizontal cables for wet environments in ducts/conduits
1. Requirements
- a. To be used for pathways in or below slab-on-grade, or where any part of pathway is external to the building or in a Wet or Damp Location (as defined by the NEC).
 - 1) Pathway shall enter the building (where it stubs up out of the slab) in the AV Equipment Room, or within 50' of AV Equipment Room. Coordinate this requirement with Division 27 section "Common Work Results for Communications".
 - b. Suitable to be in contact with standing water.
 - c. Cable construction shall be consistent with manufacturer's specifications to comply with Warranty requirements.
 - d. Minimum performance specifications: Cable shall meet requirements for Category 6 of TIA-568-C.
 - e. Four pairs of 23 AWG solid copper conductors
 - f. Cable shall be wet-rated / OSP-rated.
 - 1) And shall transition to a listed cable (plenum or riser rated as appropriate) where it enters the building.

- 2) This transition is not needed if the conduit stubs up directly into the Communications Room.

g. Cable jacket marking: Shall be legible and shall contain the following information:

- 1) Manufacturer's name
- 2) Copper Conductor Gauge
- 3) Pair Count
- 4) UL and CSA listing
- 5) Manufacturer's trade mark
- 6) Category rating
- 7) Sequential distance markings, in one foot increments

2. Manufacturer shall be:

a. From the following list, subject to Coordination and Warranty requirements:

- 1) Superior Essex OSP Broadband Category 6
- 2) Or Approved Equivalent

2.4 CATEGORY 3 HORIZONTAL CABLING

A. All products in this category shall be from a single reputable manufacturer and comply with Coordination and Warranty requirements per Part 1 of this Section unless otherwise noted.

B. Horizontal cables for dry environments

1. Requirements

- a. Minimum performance specifications: Cable shall meet requirements for Category 3 of TIA-568-C.
- b. Two pairs of 24 AWG copper conductors
- c. Cable jacket color(s) shall be
 - 1) Purple
- d. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name
 - 2) Copper Conductor Gauge

- 3) Pair Count
 - 4) UL and CSA listing
 - 5) Manufacturer's trade mark
 - 6) Category rating
 - 7) Sequential distance markings, in one foot increments
 - e. Individually insulated conductors under a common sheath
 - f. Where all cables are to be installed in conduit from outlet box to AV Equipment Rack, cable shall be riser (CMR or MPR) rated. Where any portion of any cable is routed in an air plenum space, cable shall be plenum (CMP) rated.
2. Manufacturer shall be:
- a. From the following list, subject to Coordination and Warranty requirements:
 - 1) Belden
 - 2) Hubbell
 - 3) Leviton
 - 4) Ortronics
 - 5) Panduit
- C. Horizontal cables for wet environments in ducts/conduits
1. Requirements
- a. To be used for pathways in or below slab-on-grade, or where any part of pathway is external to the building or in a Wet or Damp Location (as defined by the NEC).
 - 1) Pathway shall enter the building (where it stubs up out of the slab) in the AV Equipment Room, or within 50' of AV Equipment Room. Coordinate this requirement with Division 27 section "Common Work Results for Communications".
 - b. Suitable to be in contact with standing water.
 - c. Cable construction shall be consistent with manufacturer's specifications to comply with Warranty requirements.
 - d. Minimum performance specifications: Cable shall meet requirements for Category 3 of TIA-568-C.
 - e. Two pairs of 24 AWG solid copper conductors

- f. Cable shall be wet-rated / OSP-rated.
 - 1) And shall transition to a listed cable (plenum or riser rated as appropriate) where it enters the building.
 - 2) This transition is not needed if the conduit stubs up directly into the Communications Room.
- g. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name
 - 2) Copper Conductor Gauge
 - 3) Pair Count
 - 4) UL and CSA listing
 - 5) Manufacturer's trade mark
 - 6) Category rating
 - 7) Sequential distance markings, in one foot increments
- 2. Manufacturer shall be:
 - a. From the following list, subject to Coordination and Warranty requirements:
 - 1) Superior Essex
 - 2) Or Approved Equivalent

2.5 SHIELDED CATEGORY 6 CONNECTIVITY

- A. All products in this category shall be from a single reputable manufacturer and comply with Coordination and Warranty requirements per Part 1 of this Section unless otherwise noted.
- B. Connectors / Jacks
 - 1. General Requirements
 - a. Outlets shall meet requirements for Category 6 of TIA-568-C.
 - b. All 8-position modular jacks are to be wired according to the TIA T568B pin/pair assignments.
 - c. Outlet hardware shall be UL listed.
 - 2. Female RJ-45 Shielded Category 6 Jack

- a. For installation with shielded Category 6 cable into:
 - 1) Dedicated AV LAN faceplates (where no other type of AV connectors are needed)
 - 2) Rack-mounted Patch Panels
 - b. Manufacturer shall be from the following list, subject to Coordination and Warranty requirements:
 - 1) Ortronics TracJack
 - 2) Belden Key Connect
 - 3) Hubbell UDX
 - 4) Leviton QuickPort
 - 5) Panduit Mini-Com
3. Male RJ-45 Shielded Category 6 connector
- a. For installation onto far end of shielded Category 6 cable at the following locations only:
 - 1) In-wall Touch Panels
 - 2) Crestron DM Transmitters & Receivers
 - 3) Other locations where it is not practical to terminate cabling onto a faceplate or into a small Surface Mount (Biscuit) Box.
 - b. Manufacturer shall be from the following list, subject to Coordination and Warranty requirements:
 - 1) Ortronics TracJack
 - 2) Belden Key Connect
 - 3) Hubbell UDX
 - 4) Leviton QuickPort
 - 5) Panduit Mini-Com
4. EtherCON Female RJ-45 Shielded Category 6 connector
- a. For installation in custom AV faceplates where other types of AV connectors are needed
 - b. Manufacturer shall be:
 - 1) Refer to Division 27 Section “Audio Video Systems”

C. Faceplates – where only AV LAN connectors are needed, such as behind a TV

1. Requirements

- a. Stainless Steel with number of ports to allow all modular jacks to be installed as required, and as indicated on the drawings.
- b. Color shall be matched to electrical Single gang or double gang, as noted on the drawings or required to provide a complete and functioning system

2. Product shall be as follows, subject to Coordination and Warranty requirements:

- a. From the following list:
 - 1) Belden Key Connect
 - 2) Hubbell UDX
 - 3) Leviton QuickPort
 - 4) Ortronics TracJack
 - 5) Panduit Mini-Com
 - 6) Or Approved Equivalent
- b. Decora-style inserts
 - 1) Provide as necessary per drawings/details
 - 2) Color shall match faceplate or electrical, or as directed by the architect
- c. Blank inserts
 - 1) Provide blank modules to fill any unused openings in faceplates
 - 2) Color shall match other jack colors

D. Surface mount (“Biscuit”) box – for installation as needed in junction/back box, projector lift, etc. where installation of a faceplate is not practical.

1. Requirements

- a. Thermoplastic surface-mount style box with number of ports to allow all jacks to be installed as required, and as indicated on the drawings.

2. Product shall be as follows, subject to Coordination and Warranty requirements:

- a. From the following list:
 - 1) Belden KeyConnect Side-Entry Box

- 2) Hubbell iStation Surface Mount Box
- 3) Leviton QuickPort Surface-Mount Box
- 4) Ortronics TracJack Surface Mount Box
- 5) Panduit Mini-Com Surface Mount Box

E. Modular Category 6 Patch Panels

1. Requirements

- a. Be of a modular metal design with snap in frames for individual jacks/connectors.
- b. Ports and panels shall be easy to identify with label holders for machine-printed and color-coded labels. Rack mountable patch panels shall mount to standard 19" wide racks.
- c. Comply with referenced standards. Cables shall be terminated with connecting hardware of same category or higher.
- d. Patch panels shall be provided complete with all mounting hardware, modular jacks, retainers, wire guides, designation strips, etc.
- e. Provide enough patch panels for the number of cables terminated on the patch panel, plus 10 percent spare. Provide modular jacks to fill each panel completely. Do not leave any blank openings.

2. Product shall be as follows, subject to Coordination and Warranty requirements:

- a. From the following list:
 - 1) Belden KeyConnect Modular Patch Panels
 - 2) Hubbell UDX Panels
 - 3) Leviton QuickPort Patch Panels
 - 4) Ortronics OR-PHDPJU24
 - 5) Panduit Mini-Com Modular Patch Panels

2.6 CATEGORY 6 CONNECTIVITY

- A. All products in this category shall be from a single reputable manufacturer and comply with Coordination and Warranty requirements per Part 1 of this Section unless otherwise noted.

B. Connectors / Jacks

1. General Requirements

- a. Outlets shall meet requirements for Category 6 of TIA-568-C.
 - b. All 8-position modular jacks are to be wired according to the TIA T568B pin/pair assignments.
 - c. Outlet hardware shall be UL listed.
2. Female RJ-45 Category 6 Jack
- a. For installation with Category 6 cable into:
 - 1) Dedicated AV LAN faceplates (where no other type of AV connectors are needed)
 - 2) Rack-mounted Patch Panels
 - b. Manufacturer shall be from the following list, subject to Coordination and Warranty requirements:
 - 1) Ortronics TracJack
 - 2) Belden Key Connect
 - 3) Hubbell UDX
 - 4) Leviton QuickPort
 - 5) Panduit Mini-Com
3. Male RJ-45 Category 6 connector
- a. For installation onto far end of Category 6 cable at the following locations only:
 - 1) In-wall Touch Panels
 - 2) Crestron DM Transmitters & Receivers
 - 3) Other locations where it is not practical to terminate cabling onto a faceplate or into a small Surface Mount (Biscuit) Box.
 - b. Manufacturer shall be from the following list, subject to Coordination and Warranty requirements:
 - 1) Ortronics TracJack
 - 2) Belden Key Connect
 - 3) Hubbell UDX
 - 4) Leviton QuickPort
 - 5) Panduit Mini-Com

4. EtherCON Female RJ-45 Category 6 connector
 - a. For installation in custom AV faceplates where other types of AV connectors are needed
 - b. Manufacturer shall be:
 - 1) Refer to Division 27 Section “Audio Video Systems”
- C. Faceplates – where only AV LAN connectors are needed, such as behind a TV
 1. Requirements
 - a. Stainless Steel with number of ports to allow all modular jacks to be installed as required, and as indicated on the drawings.
 - b. Color shall be matched to electrical
 - c. Single gang or double gang, as noted on the drawings or required to provide a complete and functioning system
 2. Product shall be as follows, subject to Coordination and Warranty requirements:
 - a. From the following list:
 - 1) Belden Key Connect
 - 2) Hubbell UDX
 - 3) Leviton QuickPort
 - 4) Ortronics TracJack
 - 5) Panduit Mini-Com
 - 6) Or Approved Equivalent
 - b. Decora-style inserts
 - 1) Provide as necessary per drawings/details
 - 2) Color shall match faceplate or electrical, or as directed by the architect
 - c. Blank inserts
 - 1) Provide blank modules to fill any unused openings in faceplates
 - 2) Color shall match other jack colors
- D. Surface mount (“Biscuit”) box – for installation as needed in junction/back box, projector lift, etc. where installation of a faceplate is not practical.

1. Requirements
 - a. Thermoplastic surface-mount style box with number of ports to allow all jacks to be installed as required, and as indicated on the drawings.
2. Product shall be as follows, subject to Coordination and Warranty requirements:
 - a. From the following list:
 - 1) Belden KeyConnect Side-Entry Box
 - 2) Hubbell iStation Surface Mount Box
 - 3) Leviton QuickPort Surface-Mount Box
 - 4) Ortronics TracJack Surface Mount Box
 - 5) Panduit Mini-Com Surface Mount Box

E. Modular Category 6 Patch Panels

1. Requirements
 - a. Be of a modular metal design with snap in frames for individual jacks/connectors.
 - b. Ports and panels shall be easy to identify with label holders for machine-printed and color-coded labels. Rack mountable patch panels shall mount to standard 19" wide racks.
 - c. Comply with referenced standards. Cables shall be terminated with connecting hardware of same category or higher.
 - d. Patch panels shall be provided complete with all mounting hardware, modular jacks, retainers, wire guides, designation strips, etc.
 - e. Provide enough patch panels for the number of cables terminated on the patch panel, plus 10 percent spare. Provide modular jacks to fill each panel completely. Do not leave any blank openings.
2. Product shall be as follows, subject to Coordination and Warranty requirements:
 - a. From the following list:
 - 1) Belden KeyConnect Modular Patch Panels
 - 2) Hubbell UDX Panels
 - 3) Leviton QuickPort Patch Panels
 - 4) Ortronics OR-PHDPJU24
 - 5) Panduit Mini-Com Modular Patch Panels

2.7 CATEGORY 3 CONNECTIVITY

- A. All products in this category shall be from a single reputable manufacturer and comply with Coordination and Warranty requirements per Part 1 of this Section unless otherwise noted.
- B. Connectors / Jacks
 - 1. General Requirements
 - a. Outlets shall meet requirements for Category 3 of TIA-568-C.
 - b. Outlet hardware shall be UL listed.
 - 2. Female Category 3 Jack
 - a. For installation with Category 3 cable into:
 - 1) Dedicated AV LAN faceplates (where no other type of AV connectors are needed)
 - 2) Rack-mounted Patch Panels
 - b. Manufacturer shall be from the following list, subject to Coordination and Warranty requirements:
 - 1) Ortronics TracJack
 - 2) Belden Key Connect
 - 3) Hubbell UDX
 - 4) Leviton QuickPort
 - 5) Panduit Mini-Com
 - 3. Male Category 3 connector
 - a. For installation onto far end of Category 3 cable at the following locations only:
 - 1) Locations where it is not practical to terminate cabling onto a faceplate or into a small Surface Mount (Biscuit) Box.
 - b. Manufacturer shall be from the following list, subject to Coordination and Warranty requirements:
 - 1) Ortronics TracJack
 - 2) Belden Key Connect
 - 3) Hubbell UDX
 - 4) Leviton QuickPort

5) Panduit Mini-Com

C. Faceplates – where only AV LAN connectors are needed, such as behind a TV

1. Requirements

- a. Stainless Steel with number of ports to allow all modular jacks to be installed as required, and as indicated on the drawings.
- b. Color shall be matched to electrical
- c. Single gang or double gang, as noted on the drawings or required to provide a complete and functioning system

2. Product shall be as follows, subject to Coordination and Warranty requirements:

- a. From the following list:
 - 1) Belden Key Connect
 - 2) Hubbell UDX
 - 3) Leviton QuickPort
 - 4) Ortronics TracJack
 - 5) Panduit Mini-Com
 - 6) Or Approved Equivalent
- b. Decora-style inserts
 - 1) Provide as necessary per drawings/details
 - 2) Color shall match faceplate or electrical, or as directed by the architect
- c. Blank inserts
 - 1) Provide blank modules to fill any unused openings in faceplates
 - 2) Color shall match other jack colors

D. Surface mount (“Biscuit”) box – for installation as needed in junction/back box, projector lift, etc. where installation of a faceplate is not practical.

1. Requirements

- a. Thermoplastic surface-mount style box with number of ports to allow all jacks to be installed as required, and as indicated on the drawings.

2. Product shall be as follows, subject to Coordination and Warranty requirements:

- a. From the following list:
 - 1) Belden KeyConnect Side-Entry Box
 - 2) Hubbell iStation Surface Mount Box
 - 3) Leviton QuickPort Surface-Mount Box
 - 4) Ortronics TracJack Surface Mount Box
 - 5) Panduit Mini-Com Surface Mount Box

2.8 SHIELDED CATEGORY 6 PATCH CABLES/CORDS

- A. All products in this category shall be from a single reputable manufacturer and comply with Coordination and Warranty requirements per Part 1 of this Section unless otherwise noted.
- B. Requirements
 - 1. Factory-terminated and tested
 - 2. Shall meet requirements for Category 6 of TIA-568-C
 - 3. Shielded
 - 4. Provide quantities and lengths as necessary for a complete Audio Video System; coordinate requirements with Division 27 "Audio Video Systems" contractor.
 - 5. In the AV Equipment Room/Rack, Color shall correspond to the following VLANs:
 - a. Crestron/AMX/Extron AV distribution/control – black
 - b. IP / Control connections – purple
 - c. Audio Networks – blue
 - d. HDBaseT distribution – grey
 - 6. For all far-end connections, color shall be black.
 - 7. Provide the following spares, delivered to the Owner at time of Owner AV Training
 - a. (10) purple 3 foot patch cords
 - b. (10) purple 7 foot patch cords
- C. Product shall be from the same manufacturer as the patch panel manufacturer:
 - 1. From the following list:

- a. Belden
- b. Hubbell
- c. Leviton
- d. Ortronics
- e. Panduit

2.9 CATEGORY 6 PATCH CABLES/CORDS

- A. All products in this category shall be from a single reputable manufacturer and comply with Coordination and Warranty requirements per Part 1 of this Section unless otherwise noted.
- B. Requirements
 - 1. Factory-terminated and tested
 - 2. Shall meet requirements for Category 6 of TIA-568-C
 - 3. Provide quantities and lengths as necessary for a complete Audio Video System; coordinate requirements with Division 27 "Audio Video Systems" contractor.
 - 4. In the AV Equipment Room/Rack, Color shall correspond to the following VLANs:
 - a. Crestron/AMX/Extron AV distribution/control – black
 - b. IP / Control connections – purple
 - c. Audio Networks – blue
 - d. HDBaseT distribution – grey
 - 5. For all far-end connections, color shall be black.
 - 6. Provide the following spares, delivered to the Owner at time of Owner AV Training
 - a. (10) purple 3 foot patch cords
 - b. (10) purple 7 foot patch cords
- C. Product shall be from the same manufacturer as the patch panel manufacturer:
 - 1. From the following list:
 - a. Belden
 - b. Hubbell

- c. Leviton
- d. Ortronics
- e. Panduit

2.10 CATEGORY 3 PATCH CABLES/CORDS

- A. All products in this category shall be from a single reputable manufacturer and comply with Coordination and Warranty requirements per Part 1 of this Section unless otherwise noted.
- B. Requirements
 - 1. Factory-terminated and tested
 - 2. Shall meet requirements for Category 3 of TIA-568-C
 - 3. Provide quantities and lengths as necessary for a complete Audio Video System; coordinate requirements with Division 27 "Audio Video Systems" contractor.
 - 4. Jacket color shall be black.
 - 5. Provide the following spares, delivered to the Owner at time of Owner AV Training
 - a. (10) purple 3 foot patch cords
 - b. (10) purple 7 foot patch cords
- C. Product shall be from the same manufacturer as the bulk cable:
 - 1. From the following list:
 - a. Belden
 - b. Hubbell
 - c. Leviton
 - d. Ortronics
 - e. Panduit

2.11 COPPER ENTRANCE PROTECTION

- A. General
 - 1. Fully protect each end of all incoming conductors which are considered to have lightning exposure in accordance with NEC chapter 8.

B. Category 6 Surge Protection

1. General
 - a. Shall meet UL 497
 - b. Shall exceed TIA/EIA 568 Category 6 performance standards
 - c. Shall be capable of being used with POE+ applications
2. Wall-mount Protectors – for single cables, where quantity of cables in Equipment Room needing protection is 6 or less
 - a. Manufacturer shall be:
 - 1) Emerson Edco CAT6-POE
 - 2) ITWLinx SurgeGate Series CAT6-75
3. Rack-mount Protectors – where more than 6 cables in an Equipment Room require surge protection
 - a. Shall be rack-mountable in 19" wide equipment rack
 - b. Provide quantity of Category 6 protectors/modules required for install, plus 25% spare
 - c. Manufacturer shall be:
 - 1) APC ProtectNet Chassis (PRM24) with Cat 6 Surge Modules (PNETR6)
 - 2) Emerson Edco RM-CAT6-**POE
4. Far-end Protection – exterior Category 6 outlets should have integral protection against power surges and transients. Where AV equipment does not have integral protection, provide the following at the far-end of each exterior Category 6 outlet:
 - 1) Blackbox CAT6 In-Line Surge Protector
 - 2) Emerson CAT6-5POE-FF

2.12 COPPER TESTING EQUIPMENT

A. The following Test Equipment is Conditionally Approved for Contractor use.

B. Category 6 Cable Tester

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.
 - a. Category 6 Cable Tester

- | | | |
|----|----------|--|
| 1) | Fluke | www.flukenetworks.com |
| 2) | Greenlee | www.greenlee.com |
| 3) | Ideal | www.idealindustries.com |
| 4) | JDSU | www.jdsu.com |

2. Requirements

- a. The field tester shall be a level III or greater.
- b. The field tester shall meet the requirements of TIA-568.

C. Category 3 Cable Tester

- 1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.
 - a. Category 3 Cable Tester
 - 1) Fluke www.flukenetworks.com
 - 2) Greenlee www.greenlee.com
 - 3) Ideal www.idealindustries.com
 - 4) JDSU www.jdsu.com
- 2. Requirements
 - a. The field tester shall meet the requirements of TIA-568.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 CABLE INSTALLATION

A. General

- 1. Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications.
 - a. There shall be no splices or mechanical couplers installed between the cable points of origin and termination except as shown on the Drawings and/or specified herein.

- b. No horizontal Category 6 cables shall exceed the allowed maximum distance of 295 feet (90 meters) by TIA-568-C.
2. Unless otherwise noted, all cables shall be routed through the building cable tray/conduit/surface-mounted raceway system.
 - a. All horizontal cables shall be suitable for installation in their environment, either plenum (CMP, MPP, OFNP, or OFCP) or riser (CMR, MPR, OFNR, or OFCR) rated, unless otherwise noted.
 - b. Horizontal cables installed in Wet Locations as defined by the NEC or in these construction documents (such as conduits embedded or routed below a ground floor slab) shall be suitable for installation in such environments and follow the installation requirements for outside plant cables as specified herein.
3. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.
 - a. Except when supported by ladder racking within each AV Equipment Room/Rack, UON.
4. At the same time horizontal cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200 lb (90.72 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
5. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable
6. Comply with all referenced standards and guidelines.
7. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.
8. Where distance allows all horizontal cables shall be provided with slack/service loops at each end of the cable, one at the device (if not in conduit) and one at the equipment room/enclosure. Each slack/service loop shall be:
 - a. A minimum of 8 feet (2.44 meter) in length, UNO
 - b. Configured in a loosely formed figure eight configuration (ie. not coiled)
9. Use of any cable pulling lubricants is prohibited.
 - a. Where lubricant is deemed necessary by the contractor to facilitate installation of cable in conduit, submit RFI with explanation, effected conduit run, proposed lubricant type, letter from cable manufacturer indicating proposed lubricant will not damage or degrade cable, and a letter from the manufacturer providing the Advanced System Warranty (if applicable) that the use of this lubricant will not exclude that cable run from the required warranty.

- B. Outside plant cable installation: for cables placed in Wet or Damp Locations (as defined by the NEC) or as required by these construction documents. (I.e. all cables which extend beyond the footprint/envelope of the building or pathways leading to floor-boxes embedded in a ground floor slab)
1. Coordinate installation of conduit serving Wet Locations so conduit stubs up directly into Equipment Room, if practical.
 2. If conduit serving Wet Locations cannot be installed so conduit stubs up directly into Equipment Room, utilize IMC or RMC conduit to within 50 feet (15.24 meter) of the cable termination point.
 3. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling space nor shall they be allowed to transition between different levels of the building.
 4. Where specifically allowed by these construction documents cable jackets rated for dual use by a NRTL, such as an indoor/outdoor rated cable may be used.
 - a. These cables may be installed in locations within the building in which the cable jacket is appropriately rated to meet all applicable building codes.
 5. All cables which extend beyond the envelope/footprint of the building or serving outlets/devices on external walls or roofs shall be installed with entrance protectors in accordance with this section.
- C. Fiber Splices
1. In general, optical fiber cables shall not to be spliced except where indicated otherwise in the Drawings and Specifications.
 2. Where splicing is indicated in the Drawings and Specifications, multi-mode and single-mode optical fiber cable splicing shall be fusion spliced.
 3. In the Communications Room / at the Equipment Rack, instead of field terminating the optical fiber cables onto appropriate type connectors, splice the optical fiber cables near their termination points to connectors that have been factory pre-terminated with optical fiber pig-tails. The following requirements apply to the use of this termination approach:
 - a. All Multi-mode and single-mode optical fiber strands shall be spliced to factory pre-terminated pig-tails with matching fiber type/diameter.
 - b. Rack mounted splice tray enclosures shall be by the same manufacturer as the optical fiber connector panels.
 - c. Trays shall be used to hold all splices.
 - d. Optical fiber cables shall be labeled at the splice trays.

3.3 CONNECTOR INSTALLATION

- A. Furnish and install all cable connectors as shown on the Drawings.

- B. Provide number of connectors as required by the Drawings and as required by these documents, where the number of connectors required does not fill the entire faceplate provide blank inserts so that no opening is left.
- C. The provision and termination of connectors from each cable shall be done as follows:
 - 1. Where connector types are identified on the applicable drawings or in the specifications, furnish and install the specified connectors on the specified cables. Installation of the connectors shall be in accordance with the manufacturer's printed instructions.
 - 2. All installed connectors, regardless of type, method of procurement or permanency, shall be adequately protected during and after installation.
- D. Copper Connector Installation
 - 1. Terminate all four pairs of each cable on one outlet jack. Ensure shield/foil and drain wire are properly installed according to manufacturer's instructions.
 - 2. Furnish and install all cable connectors as shown on the Drawings or as indicated herein, unless otherwise noted.
 - 3. The provision and termination of connectors for each cable shall be done as follows:
 - a. Where connector types are identified on the applicable drawings or in the specifications, Furnish and install the specified connectors on the specified cables. Installation of the connectors shall be in accordance with the manufacturer's printed instructions.
 - b. All installed connectors, regardless of type, method of procurement or permanency, shall be adequately protected during and after installation.
- E. Fiber Optic Connector Installation
 - 1. In the Equipment Room, all fiber optic cable strands shall be fusion-spliced to factory-terminated pigtailed adapters.
 - 2. At device end, terminate/splice all fiber optic cable strands as shown on the Drawings.
 - 3. All fiber optic connectors shall be installed with dust caps/covers.

3.4 FACEPLATE INSTALLATION

- A. Furnish and install all faceplates in locations as shown on the Drawings.
 - 1. Where co-located on AV faceplates, coordinate installation with Division 27 "Audio Video Systems" contractor.

3.5 CABLE IDENTIFICATION

- A. Label all cabling with machine-printed labels according to the labeling scheme identified on the drawings. If the drawings do not address labeling scheme, submit RFI through appropriate channels requesting labeling scheme.
 - 1. Shop drawings shall include floor plan that indicates proposed cable/outlet identification for each outlet.
- B. Cables shall be labeled within 6" at each end.
- C. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:
 - 1. Brady, IDXPRT
 - 2. Hellermann Tyton, Spirit 2100
 - 3. Panduit LS9
 - 4. Or Approved Equivalent

3.6 ENTRANCE PROTECTION INSTALLATION

- A. Install grounding wire as straight as possible from protector to the Technical System Ground.
- B. Grounding and bonding
 - 1. Bond all metallic shields and armored jacketing material for all incoming cables as close as practicable to the entry into the building.
 - 2. Bonding conductors shall be connected to the Technical System Ground and in accordance with NEC chapter 8.

3.7 GENERAL CABLE TESTING

- A. Pre-installation testing:
 - 1. Visually inspect all cables, cable reels/boxes, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
 - 2. Mark reels or boxes as tested/inspected.
 - 3. Do not install any cable with less than the manufacturer's guaranteed number of serviceable conductors.
 - 4. The field-test instruments shall be within the calibration period recommended by the manufacturer and shall contain the most recent software and firmware provided by the manufacturer prior to testing.

B. Post-installation testing:

1. Conduct cable testing as described below upon completion of installation. Test fully completed systems only. Piecemeal testing is not acceptable.
2. Provide testing in accordance with manufacturer's requirements for a fully warranted cabling system(s) as required by these Contract Documents.
3. All outlets, cables, patch panels, and associated components shall be fully assembled and labeled prior to field testing.
4. Invite the Owner and Design Consultant to witness, review, or both witness and review field-testing.
 - a. The Owner and the Design Consultant shall be notified of the testing start date (2) weeks before testing commences.
5. Remove all defective cables from pathway systems.
6. All cables that fail testing are to be corrected prior to substantial completion and acceptance by owner. Replace entire cable if bad pair or conductor is found. Do not abandon cables in place.

C. All test results and corrective procedures are to be documented and submitted to the Design Consultant as part of the Project Completion submittal(s) and the Contractor's Testing and Adjustment requirements of Division 27 Section "Audio Video Systems".

1. Submit updated Record Drawings along with completed Test Results. Record Drawings shall have final outlet labels that correspond to the identification used in the Test Results.
2. Format of test results shall be:
 - a. Electronic Database Test Results - Abbreviated results, in PDF and Excel/CSV file formats, shown in numerical / alphabetical order in a spreadsheet which depicts the following:
 - 1) Project Name
 - 2) Date of Preparation
 - 3) ID of Work Area Outlet / connector being tested
 - 4) Date of test
 - 5) Contractor's Name
 - 6) Media Type
 - 7) Make, Model and Serial Number of test equipment used
 - 8) Date of Last Calibration

- 9) Names of Test Crew
- 10) Serving Communications Room Number
 - a) All tests shall be submitted in numerical / alphabetical order by Communications / Equipment Room.
- 11) Category of cable being tested
- 12) Abbreviated Test Results depicting Pass, Fail status
- b. Full Test Results – test results saved within the field-test instrument and then transferred into a Windows-based database utility that allows for the maintenance, inspection, and archiving of the test records, shown in numerical / alphabetical order in the file format of the tester (example: .mdb file, and unaltered).
 - 1) Project Name
 - 2) Date of Preparation
 - 3) ID of Work Area Outlet / connector being tested
 - 4) Date of test
 - 5) Contractor's Name
 - 6) Media Type
 - 7) Make, Model and Serial Number of test equipment used
 - 8) Date of Last Calibration
 - 9) Names of Test Crew
 - 10) Serving Telecommunications Room Number
 - a) All tests shall be listed in numerical / alphabetical order by Communications / Equipment Room.
 - 11) Category of cable being tested
 - 12) Full Test Result data

D. Final Acceptance Review

1. Final Acceptance Review will take place in conjunction with the Design Consultant Commissioning as specified in Division 27 Section "Audio Video Systems". Final Acceptance Review cannot take place until Design Consultant receives Test Results and Record Drawings.

2. Provide a minimum of two suitably qualified cabling/testing technicians to be present on-site for a period of four hours during the scheduled Final Acceptance Review. Be prepared to conduct on-the-spot cable tests.
3. During the Final Acceptance Review, the Owner or the Design Consultant may select a random sample of up to 10% of the installed links for the Contractor to retest. The measured results obtained from the random sample shall be compared to the Test Results provided by the Contractor.
4. If 10% or more of the randomly tested cables differ in terms of the pass/fail determination or in cable length, the Owner and Design Consultant reserve the right to require a re-testing of 100% of the cable plant at the Contractor's expense.
5. Successful equipment performance tests do no relieve the Contractor from the specified testing, repair, and documentation requirements.

3.8 COPPER CABLE TESTING

- A. Perform all manufacturer recommended and required test calibration procedures prior to testing any cables.
- B. Four-Pair Cables:
 1. After terminating both ends of all 4-pair cables, but before any cross-connects are installed, test these cables for the following:
 - a. Category 6
 - 1) Wire map
 - 2) Length
 - 3) Insertion loss
 - 4) Near-end crosstalk (NEXT) loss.
 - 5) Power sum near-end crosstalk (PSNEXT)
 - 6) Equal-level far-end crosstalk (ELFEXT)
 - 7) Power sum equal-level far-end crosstalk (PSELFEXT)
 - 8) Return loss
 - 9) Propagation delay
 - 10) Delay skew
- C. Two-Pair Cables:

1. After terminating both ends of all 2-pair cables, but before any cross-connects are installed, test these cables for the following:
 - a. Category 3
 - 1) Wire map
 - 2) Length
 - 3) Insertion loss
 - 4) Return loss
 - 5) Propagation delay
- D. All installed cabling Permanent Links shall be field-tested and pass the test requirements and analysis above. Any Permanent Link or Modified 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.

3.9 ACCEPTANCE

- A. All Work in this section is subject to the Project Completion and Schedule requirements of Division 27 section "Audio Video Systems".
- B. After Final Acceptance Review:
 1. Complete all Punch List items.
 2. Retest effected cables.
 3. Among other requirements, submit updated and complete Record Drawings/Test Results as part of Division 27 Audio Video Systems – Operation and Maintenance Data Submittal.

END OF SECTION 274110

SECTION 274116 - AUDIO VIDEO SYSTEMS EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. These specifications and the associated TA-series drawings describe the requirements for the sound and audio-video (AV) system (hereafter referred to as the “Technical System”).
- B. Refer to Division 27 Section “Audio Video Systems” for additional information.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section, as do the following:
 - 1. Division 27 Section “General Communications Requirements”.
 - 2. Division 27 Section “Common Work Results for Communications”.
 - 3. Division 27 Section “Audio Video Systems”.
 - 4. Division 27 Section “Telecommunications Requirements for Audio Video Systems”.

1.3 QUALITY ASSURANCE

- A. Refer to Division 27 Section “Audio Video Systems” for quality assurance requirements with the following modifications:
 - 1. Contractor General Qualifications:
 - a. Active membership in the National Systems Contractors Association (NSCA).
 - b. Active membership in the Audiovisual and Integrated Experience Association (AVIXA). Authorized dealer for major components of Technical System. Major components include: loudspeakers, video projectors, control systems, power amplifiers, and digital signal processors.
 - 2. Contractor Personnel Qualifications:
 - a. Minimum of one full-time staff member who has attended technical system engineering courses taught by Syn-Aud-Con in the past 10 years.
 - b. Minimum of one AVIXA CTS-I (Certified Technology Specialist - Installation) systems technician.

- c. Minimum of one full-time staff member who has a minimum of three (3) years direct experience with and is factory-certified on the most recent version of the selected Digital Signal Processor (DSP) software and technology. This individual shall be responsible for the implementation of the DSP system including software. This individual shall be the same throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.
- d. Minimum of one full-time staff member who has a minimum of three (3) years direct experience with network based-AV transport and is factory-certified on the most recent version of the selected AV transport technology. The individual shall hold a current manufacturer's certification (i.e., Crestron DMC-E). This individual shall be responsible for the implementation and preliminary commissioning of the AV transport system. This individual shall be the same throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.
- e. Minimum of one full-time staff member who has a minimum of three (3) years direct experience and is a factory certified Master Level Programmer on the most recent version of the AV control system software and technology. This individual shall be the same throughout the execution of the work unless illness or loss of personnel intervenes. A factory authorized independent programmer (i.e., Crestron Master CAIP) will also be accepted, providing the programmer meets the criteria identified in this paragraph.

1.4 SUBMITTALS

- A. Refer to requirements in Division 27 Section "General Communications Requirements".
- B. Refer to Division 27 Section "Audio Video Systems" for submittal requirements with the following alterations and additions:
 - 1. Pre-Construction
 - a. Schedule specific items include:
 - 1) Off-site: touch screen layouts, DSP configuration
 - 2) On-site under scope: rack installation, projector installation, projection screen installation, flat panel display/television installation, loudspeaker installation
 - b. Signal Flow Shop Drawings – One-line diagrams indicating full intended system configuration where it varies from the original design. Alterations from basis of design found within the Construction Documents shall be reflected and identified.
 - c. DSP Signal Flow - DSP signal flow configuration (submitted within at least three months to system first use).
 - d. AV Control System - AV control system panel/screen layouts suitable for the Owner's Representative to understand the operation and flow (submitted within at least five months prior to system first use).

2. Project Completion

- a. Refer to Division 27 Section “General Communications Requirements” and the Operation and Maintenance Data section in Part 3 of this section for additional requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Refer to Division 27 Section “Audio Video Systems” for general product requirements.
- B. All major components of technical system equipment shall be provided and installed by a qualified contractor as outlined in Part 1 of this section.
- C. All electronic audio devices shall have electronic or transformer balanced inputs and outputs except for specific program source equipment and specific mixing console inputs and/or outputs. If an electronic device specified or furnished has an unbalanced input and/or output, make provisions to balance said input/output (i.e., active signal balancing device as approved) unless other arrangements have been agreed upon with the Design Consultant.

2.2 COMMON EQUIPMENT

- A. Refer to Division 27 Section “Audio Video Systems” for common equipment and components.

2.3 MICROPHONES – PORTABLE

- A. Microphone – Wired Dynamic: handheld microphone, dynamic, supercardioid. Furnish wired microphones from the same manufacturer as wireless microphones (quantity six (6) required, (2) for use in Competition Gym; (2) Media Center; (2) Commons):
 1. Shure BETA 58A with A58WS windscreen; or
 2. Sennheiser e9435 with MZW 1 windscreen; or
 3. Approved equal.
- B. Microphone – Single Ear Head worn: head worn omnidirectional microphone, condenser, for wireless belt pack transmitter, lightweight, single over-the-ear style. Coordinate connector to mate with belt pack, Contractor to coordinate color as selected by Owner’s Representative (one required for each wireless belt pack furnished):
 1. Ansr Audio AM-17 (black) or AM-17T (tan), or
 2. Shure MX153B (black) or MX153T (tan) or MX153C (cocoa); or
 3. Approved equal.
- C. Microphone – Sports Announce Stand: dynamic, stand-mounted omnidirectional microphone with windscreen (quantity two (2) required, (1) for use in Competition Gym; (1) Aux Gym):

1. Audio-technica AT8004 with AT8101; or
2. Electro-Voice RE50N/D-B with 379-1; or
3. Shure SM-63 with RK229WS; or
4. Approved equal.

2.4 MICROPHONE ACCESSORIES – PORTABLE

- A. Microphone Stand – SB: microphone floor stand with solid base, black (quantity six (6) required, (2) for use in Competition Gym; (2) Media Center; (2) Commons):
- B. Atlas MS-20E (ebony); or
 1. K&M 260 (black); or
 2. QuikLok A-399 (black) with fully filled base; or
 3. Ultimate Pro-SB (stackable); or
 4. Approved equal.

2.5 WIRELESS MICROPHONE SYSTEMS

- A. Furnish complete UHF diversity wireless microphone system(s) including the following components (select components from one manufacturer listed below):
- B. Wireless Microphone Receiver: furnish single, dual, or quad channel models with rack mount kits as required to achieve the number of receiver channels as shown on the drawings:
 1. Shure ULXD4 (single channel), or ULXD4D (dual channel), or ULXD4Q (four channel) digital wireless receiver with encryption capability (encryption must be off when one receiver shares more than one transmitter) with included rack mount kit; or
 2. Approved equal.
- C. Wireless Belt pack Transmitter: furnish belt pack transmitter with head worn microphone (quantity twenty (20) required; (16) for use between Competition Gym, Platform, and Commons ; (2) for use in Auxiliary Gym; (2) for use in Media Center):
 1. Shure ULXD1 with head worn microphone as specified elsewhere; or
 2. Approved equal
- D. Wireless Handheld Transmitter – Dynamic (quantity eight (8) required as follows:) (4))for use between Competition Gym, Platform, and Commons ; (2) for use in Auxiliary Gym; (2) for use in Media Center):

1. Shure ULXD2 with RPW118 (Beta 58A) head, 95T9279 microphone clip (included), and A58WS windscreen; or
 2. Approved equal.
- E. Wireless Remote Antenna: omnidirectional remote mounted antenna:
1. Shure UA8 (1/2-wave); or
 2. Shure UA860SWB (470-1100 MHz; weather resistant); or
 3. Approved equal.
- F. Wireless rechargeable battery system: including batteries, chargers, and power supplies to charge all transmitters simultaneously (one rechargeable battery and associated charging slot required for each transmitter furnished – minimum one charging slot per transmitter in each room):
1. Shure SB900A battery, SBC200-US dual charger with power supply, SBC200 dual charger expansion, SBC800-US Eight Battery Charging Station; or
 2. Approved equal.
- G. Each receiver shall be connected via Ethernet to the computer. Furnish the most recent configuration software, install on the computer, and configure each receiver and transmitter for optimum operation. Test each and all receiver/transmitters to ensure no problems arise.
- H. Where remote 1/4 wavelength antennas are used, and mounting conditions allow, mount each antenna on a standard metal wall plate to serve as a ground plane.
- I. Provide all connections and components necessary for proper operation of the wireless systems described above.
- J. Coordinate the selection of transmitter/receiver frequencies to be free of interference from outside sources or interference between wireless systems. Select the frequency from an unused channel between (470 - 608 MHz) per FCC regulations Part 74, subpart H. For additional information see <https://www.fcc.gov/consumers/guides/operation-wireless-microphones>
- K. Label each receiver/transmitter combination as noted on the drawings. See Labeling and Placards section in this specification for additional labeling requirements.

2.6 PROGRAM SOURCE EQUIPMENT

- A. Some of the program source equipment specified is consumer-grade equipment. Upon award of a contract, endeavor to procure these items as soon as possible to avoid delays caused by searching for discontinued product(s).
- B. Rack-mount kit for equipment that requires rack mounting but is not provided with rack mount ears or optional rack mount kit:
 1. Lowell RMK series; or

2. Middle Atlantic Products RSH series; or
 3. Approved equal.
- C. For each portable item of program source equipment, furnish one set of input/output cables (6-foot minimum length) and adapters (as required) to allow connection to technical system inputs/outputs.
- D. Audio Interface Wallplate Mono: single gang Decora style wallplate with 1/8" and dual RCA inputs, mono transformer-isolated line level output, passive:
1. Radio Design Labs DS*-CIJ3D (color approval required) with optional matching cover plate; or
 2. Approved equal.

2.7 MIXING CONSOLES - DIGITAL

- A. Mixer DC32/16/2, digital, mixing console with 32 mic/line inputs minimum, 16 output busses minimum, one expansion card slot minimum (quantity one (1) required for use in Competition Gym):
1. Soundcraft Si Impact 32. Furnish Littlite 18G-LED task lights (two lights required per mixer furnished); or
 - a. With Dante card
 2. Yamaha LS9-32 with the following options:
 - a. PM-LIGHT 18" gooseneck lamp, 4-pin XLR connector
 - b. Mixer shall be connected to a UPS on an unswitched AC power circuit; or
 - c. With Dante card
 3. Approved equal.

2.8 MIXERS

- A. Mixer - Portable 8-CH, small, with balanced inputs and balanced outputs (quantity one (1) require; one (1) for use in Competition Gym):
1. Allen & Heath ZEDi-8; or
 2. Mackie 802-VLZ4 with one 1/4" TRS to male XLR adapter for each output; or
 3. Approved equal.

2.9 DIGITAL SIGNAL PROCESSING (DSP)

- A. The AC power cord of the DSP shall be connected to a rack-mount uninterruptible power supply (UPS). Refer to the AC Power section for specific models. The UPS shall be connected to an unswitched (unsequenced) AC power circuit.
- B. Create all schematics for the DSP and submit as a shop drawing.
- C. Provide one computer with mouse and system features as recommended and approved by the manufacturer of the DSP system for use during commissioning.
 - 1. If a computer is provided under this specification section for use as a system operation and configuration device, DSP software should be loaded and computer should be operational during system commissioning.
 - 2. Furnish a wireless 802.11n router and laptop computer configured to allow for wireless control of the DSP during system testing and commissioning if applicable to the facility. Retain ownership of the router and laptop computer.
- D. Password protection shall be included. One password shall be provided to allow operator access to select functions. Another password shall be provided for technical staff to access all aspects of the software.
- E. Furnish all components for a fully functioning digital signal processing system.
- F. DSP system basis of design is shown on the signal flows. Unterminated IO cards should be provided as indicated on the signal flows for future use or additional requirements.
- G. Substitutes to the basis of design will be considered if all features and functionality of the system requirements are met. IO requirements should meet or exceed the quantity of the basis of design. Processing requirements should meet or exceed the basis of design to ensure proper operation of the system. The following manufacturers are pre-approved substitutes:
 - 1. QSC Q-Sys with:
 - a. The most recent Q-Sys Designer software; or
 - 2. Biamp Nexia with:
 - a. The most recent Nexia software; or
 - 3. Biamp Tesira with:
 - a. The most recent Tesira software; or
 - 4. BSS Soundweb London with:
 - a. The most recent London Architect software; or
 - 5. Symetrix Edge with:

- a. The most recent SymNet Composer software.

2.10 POWER AMPLIFIERS

- A. Power amplifiers in this section shall be by one manufacturer and operated in multi-channel mode to provide a minimum of two amplifier channels within one chassis unless noted otherwise.
- B. All power amplifiers shall have either electronic or transformer balanced inputs, and shall have either stepped input level attenuators or control via software.
- C. Provide perforated metal security cover (type as specified herein) for each amplifier, to cover all front panel controls and AC power switches. Security cover shall not block air-flow for amplifier internal cooling system.
- D. All power amplifiers shall have standby/sleep mode functionality. This functionality should be implemented on a system wide scale to provide a fully controlled power sequencing system. Preferred solution is networked based; if amplifier does not have necessary features via network control, contact closure solution should be utilized. Contact closure solution shall utilize a control system for triggering power state.
 1. Upon system shutdown, power amplifiers shall enter standby/sleep mode per manufacturer's functionality.
- E. Power amplifiers are listed by series, with the basis of design model shown on the signal flows. Deviation from the basis of design to an approved substitute will be allowed as follows:
 1. Power rating for high impedance (70V) operation shall meet or exceed the basis of design load requirement on the channel. Load shall be calculated based on total power (addition of all loudspeaker tap values) as indicated on the signal flows.
 2. Power rating for low impedance operation shall meet or exceed the basis of design load requirement on the channel. Load shall be as indicated on the signal flows.
 3. Channel count per chassis should produce most efficient solution of maximum channels vs appropriate power rating.
 4. Proposed substitute should take into account:
 - a. alterations of audio network requirements, as applicable. Alterations may include the need for additional network infrastructure, including network switches.
 - b. alterations of audio system requirements, as applicable. Alterations may include the need for additional digital signal processing infrastructure.
 - c. standby/sleep mode functionality. Alterations may include the need for additional network infrastructure or control system infrastructure.
 - d. all other parameters, including but not limited to rack requirements and environmental considerations (AC power, thermal dissipation, etc.).

- F. Power Amplifier – Type (####)x/(#)N(A)(B)(C)(D)(E)(Q): power amplifier, high (70V) or low impedance operation switchable per output, network control, loudspeaker processing, audio network capabilities, with the following characteristics required as shown on signal flows:
1. QSC CX-Q Series
 - a. ####x, minimum power rating listed at 8-ohm load, also capable of providing high impedance (70V) operation
 - b. /#, number of channels per chassis
 - c. N, network control capabilities
 - d. Q, Q-Sys
 2. Ashly nXp Series with audio network card
 - a. ####x, minimum power rating listed at 8-ohm load, also capable of providing high impedance (70V) operation
 - b. /#, number of channels per chassis
 - c. N, network control capabilities
 - d. With
 - e. A, AVB card, model OPAVB
 - f. C, Cobranet card, model CNM-2
 - g. D, Dante card, model OPDante
 3. Bose PM N Series with audio network card
 - a. ####x, minimum power rating listed at 8-ohm load, also capable of providing high impedance (70V) operation
 - b. /#, number of channels per chassis
 - c. N, network control capabilities
 - d. With
 - e. C, Cobranet card
 - f. D, Dante card
 4. Crown DriveCore Install (DCI) Series Network
 - a. ####x, minimum power rating listed at 8-ohm load, also capable of providing high impedance (70V) operation

- b. /#, number of channels per chassis
- c. N, network control capabilities
- d. A, AVB
- e. B, BLU-Link
- f. D, Dante

5. Lab.gruppen D Series “/Ta” Models

- a. #####x, minimum power rating listed at 8-ohm load, also capable of providing high impedance (70V) operation
- b. /#, number of channels per chassis
- c. N, network control capabilities
- d. A, AVB (Biamp Tesira insideDSP)
- e. D, Dante (Dolby Lake DSP)

2.11 LOUDSPEAKERS – INSTALLED

A. General loudspeaker requirements:

- 1. Loudspeaker, and related mounting bracket(s) where appropriate, color shall be as selected by the Architect from the available color selection offered from each loudspeaker manufacturer.
- 2. Utilize the most recent manufacturer-recommended DSP settings if available.

B. Loudspeaker CF|70|4|-, ceiling, four-inch loudspeaker, complete with enclosure, and integrated 70 volt transformer, switchable to 8 ohm:

- 1. Community D4; or
- 2. Martin Audio C4.8T; or
- 3. Tannoy CMS 401DCe; or
- 4. Approved equal.

C. Loudspeaker PM|70|8|-, pendant mount, eight-inch loudspeaker, integrated 70 volt transformer, switchable to 8 ohm, furnish hanging method:

- 1. Community DP8; or
- 2. Approved equal.

- D. Loudspeaker TR|08|08\90:60, front loaded, full range, eight-inch two-way loudspeaker, 8-ohm, 90x60 dispersion with rotatable waveguide:
 - 1. Electro-Voice EVC-1082/96; or
 - 2. Approved equal.
- E. Loudspeaker TR|08|08\100:100, front loaded, full range, eight-inch two-way loudspeaker, 8-ohm, 100x100 dispersion:
 - 1. Electro-Voice EVC-1082/00; or
 - 2. Approved equal.

2.12 ASSISTIVE LISTENING SYSTEM - FM 72MHZ

- A. The transmitter shall be installed in the audio equipment racks and the transmitting antenna shall be remotely mounted/suspended at the location shown on the drawings. The antenna shall be installed in a vertical orientation.
- B. Select interference-free frequencies corresponding to the following initial assignments, subject to revision (as approved) to avoid interference. Permanently and clearly label each receiver to match:
 - 1. Transmitter channel A “Media Center”
 - 2. Transmitter channel B “Commons”
 - 3. Transmitter channel C “Auxiliary Gym”
 - 4. Transmitter channel D “Gymnasium”
- C. The Assistive Listening System shall include all hardware as required to provide a fully-functional system.
- D. ALS Transmitter 72MHz: assistive listening system transmitter, operates in the 72MHz band:
 - 1. Listen Technologies LT-800-072-1 with LA-326 rack mount kit; or
 - 2. Telex Soundmate ST-300 with RM-S rack mount kit; or
 - 3. Williams Sound PPA T45 with RPK 005 rack mount kit.
- E. ALS Dipole Antenna 72MHz: assistive listening system antenna, coax or dipole, tuned for operation in the 72MHz band:
 - 1. Listen Technologies LA-116 (coax) or LA-122 (telescoping dipole) or LA-123 (helical); or
 - 2. Telex Soundmate HGA-1 (coax); or
 - 3. Williams Sound ANT024 (telescoping dipole) or ANT034 (helical).

- F. ALS Receiver 1CH-72MHz: assistive listening system belt pack style receiver, tuned for operation in the 72MHz band (Quantity ten (20) required, (10) for use in Gymnasium, (10) for use in Media Center):
1. Listen Technologies LR-400-072 with LA-362 NiMH batteries or LR-4200-072 (iDSP) with LA-365 Li⁺ battery; or
 2. Telex Soundmate SR-400 with NiMH batteries; or
 3. Williams Sound PPA R38N with BAT 026-2 NiMH batteries.
- G. ALS Ear Speaker: assistive listening system single ear speaker (one required for each receiver furnished):
1. Listen Technologies LA-401; or
 2. Telex Soundmate ES-1; or
 3. Williams Sound EAR 022.
- H. ALS Headphone: assistive listening system light-weight headphones (Quantity eight (8) required), (2) for use in Gymnasium , (2) for use in Auxiliary Gym, (2) for use in Commons, (2) for use in Media Center:
1. Listen Technologies LA-402; or
 2. Telex Soundmate HED-2; or
 3. Williams Sound HED 021.
- I. ALS Neckloop: assistive listening system neck loop for use with T-coil equipped hearing aids (quantity ten (20) required, (5) for use in Gymnasium, (5) for use in Auxiliary Gym, (5) for use in Commons, (5) for use in Media Center):
1. Listen Technologies LA-166 or LA-430 (iDSP); or
 2. Telex Soundmate NL-4S; or
 3. Williams Sound NKL 001.
- J. ALS Charger: assistive listening system charging case (one charging slot required for each receiver furnished, minimum one charging slot per transmitter in each room):
1. Listen Technologies LA-317 4-Slot Charging/Carrying Case or LA-423 4-Port (iDSP) USB Charger; or
 2. Listen Technologies LA-321, 8-slot Charging/Carrying Case; or
 3. Listen Technologies LA-311 16-Slot or LA-380 12-Slot (iDSP) Charging/Carrying Case; or
 4. Telex Soundmate BH-200, Charging Station for two receivers; or

5. Williams Sound CHG 3512 PRO 12-Slot Charging/Carrying Case .

- K. ALS Signage: assistive listening system signage notifying occupants that the assistive listening system is available. Mount signage as directed by the Owner's Representative (one required for entrances to each applicable room; Gymnasium, Auxiliary Gym, Commons, and Media Center):
1. Listen Technologies LA-304; or
 2. Telex Soundmate WP-1; or
 3. Williams Sound IDP 008.

2.13 AV TRANSPORT OVER IP NETWORK

- A. Twisted Pair audio and video products shall all be supplied from the same manufacturer through the signal chain (i.e. transmitter – switch – receiver).
- B. AV over IP Wallplate Encoder: single input, wallplate, audio and video distribution over a standard 1 GbE or higher ethernet network. PoE Power, Transmits 2160p60 [4:2:0] / 2160p30 [4:4:4] at least 100m, stand alone:
1. Visionary Solutions PacketAV DuetE; or
 2. Approved equal.
- C. AV over IP Decoder: single output, audio and video distribution over a standard 1 GbE or higher ethernet network. Transmits 2160p60 [4:2:0] / 2160p30 [4:4:4] at least 100m, stand alone:
1. Visionary Solutions DuetD; or
 2. Approved equal.

2.14 VIDEO DISPLAY EQUIPMENT – PROJECTORS

- A. Projector lens recommendations are based on conditions anticipated during the design phase. Site conditions may differ from the design documents. The Contractor shall be responsible for field verifying the screen size/location, projector mounting location, throw distance, lens shift capability and selection of the appropriate lens. Projectors shall be installed perpendicular to their objective screen or projection surface. Image alignment shall be via projector placement and lens shift only. Digital keystone correction is not acceptable. Digital manipulation of the image size is not an acceptable alternative to incorrect lens selection. Incorrect selection of the projector lens or incorrect installation of the projector in relation to the projection surface will not be an acceptable request for a change order.
- B. All projectors specified in this section shall have the following features or options included, unless noted otherwise for specific projectors:
1. Native 16:10 aspect ratio
 2. Native resolution no less than 1920x1200

3. Calculate lumen output specification per ANSI standard
 4. Potential for DVI, HDMI, or SDI input (as indicated on signal flows)
 5. Control via LAN or RS-232
 6. Include or provide lens capable of meeting site conditions as described above
 7. Include one spare/replacement lamp assembly (one spare lamp required per non-laser projector)
- C. Projector 12000-1200/3LCD, three chip LCD video projector, laser diode, 1920x1200 resolution, minimum of 12,000 ANSI lumens:
- a. Epson Pro L1500UHNL; or
 - b. Approved equal.
- D. Projector 4000-1200/3LCD, three chip LCD video projector, laser diode, 1920x1200 WUXGA resolution, minimum of 4,000 ANSI lumens:
1. Epson PowerLite L400U; or
 - a. Approved equal.

2.15 PROJECTOR MOUNTS & ACCESSORIES

- A. Unless noted otherwise, provide the appropriate mount for each projector furnished. Mount color as selected by Architect. Match mount to the projector and the mounting surface.
- B. Full assembly (projector, mount, and all associated connections/equipment) shall be adequately supported with the appropriate safety factor to building structure. Appropriate structural support shall be provided. No mounts shall fasten directly to the roof deck. Refer to submittal requirements.
- C. Furnish all components to provide a complete installation, including fastening systems suitable for the mounting surface.
- D. All recessed or built-in projectors require shop drawings showing the surrounding architecture to ensure proper fit and ventilation requirements.
- E. Projector Short Throw Wall Mount: short throw projector mount, fully adjustable, sized for projector as required:
 1. Chief WMA2S; or
 2. Approved equal.
- F. Projector Pole Mount: video projector mount, fully adjustable, sized for projector as required:
 1. Chief RPAU; or

2. Chief VCMU; (Heavy Duty Universal), or
 3. Peerless PRG Series; or
 4. Premier Mounts PDS-PLUS-W S; or
 5. Approved equal.
- G. Suspended Ceiling Mount Kit: video projector mounting kit with pan that rests on T-bar above suspended ceiling, supported from structure by aircraft cable, sized for projector as required:
1. Chief Suspended Ceiling Kit; or
 2. Peerless CMJ453 Variable Position Suspended Ceiling Kit; or
 3. Premier Mounts PP-FCTA-QL Hidden False Ceiling Adapter; or
 4. Approved equal.
- H. Projector Security Enclosure: steel construction, adjustable front opening, protects projector from theft or recreational damage, sized for projector as required:
1. Chief Manufacturing PG Series; or
 2. Approved equal.

2.16 FRONT PROJECTION SCREENS – INSTALLED

- A. All projection screens specified in this section shall have the following features or options included, unless noted otherwise for specific screens:
1. Matte White screen surface, 1.0 gain
 2. Black backing on screen surface
 3. Extra drop refer to audio video projection screen schedule
 - a. Screen fabric shall be fully deployed when at the specified height
 4. 16:9 aspect ratio
 5. Motorized screen and concealment door, if applicable
 6. Low voltage wall switch, location as shown on plans
- B. Projection screens are specified by series. Refer to drawings for exact screen size required per screen. Size listed as: (height in inches)-(width in inches). Deviance from basis of design size allowed +/-2”.

- C. Coordinate final mounting position with appropriate parties. Ensure screen is mounted such that screen drop is not impeded by wall mounted devices, including any electrical devices or marker boards and trays. Screen drop shall not impact wall during deployment.
- D. Ceiling mounted screens shown directly parallel to a wall surface without a given dimension are intended to be mounted such that the deployed screen surface is no more than 12" off the wall surface. If mounting conditions necessitate violation of this dimension, approval is required on an individual basis.
- E. Projection Screen - ###-###-P/T/S: motorized tensioned surface mounted projection screen. Image viewing area as listed on drawings (H" x W"):
 - 1. Da-Lite Tensioned Cosmopolitan Contour Electrol or Tensioned Large Cosmopolitan Electrol (large format) Series; or
 - 2. Draper Silhouette/Series V Series; or
 - 3. Stewart Filmscreen Cima Below Ceiling Series; or
 - 4. Stewart Filmscreen Luxus Model A Series; or
 - 5. Approved equal.

2.17 A/V CONTROL SYSTEM – EQUIPMENT

- A. Control system equipment shall be furnished from one manufacturer only. Program the system to provide acceptable operation by the Design Consultant and/or Owner's Representative.
- B. Select equipment that can be fully controlled by the control system furnished.
- C. The drawings reflect a specific system manufacturer. If a different system manufacturer is furnished, shop drawings are required indicating proposed wiring configuration, control panel layouts, and equipment used. All of the features shown for the system on the drawings shall be maintained with the substitute system including coordination and costs related to back boxes, electrical, and other associated items.
- D. All control equipment necessary shall be furnished to provide a complete operating system. The equipment listed below includes but is not limited to the following components:
 - 1. Touch Screen – W7"
 - a. QSC TSC-7W; or
 - b. Approved equal
 - 2. Network Audio Controller – 1G
 - a. QSC Axon C1; or
 - b. Approved equal.

2.18 A/V CONTROL SYSTEM – GENERAL PROGRAMMING REQUIREMENTS

- A. Refer to Division 27 Section “Audio Video Systems” for general programming requirements with the following revisions and additions:
 - 1. Provide standard audio control in the Auxiliary Gym.
 - 2. Provide standard presentation control in the Competition Gym, Commons and Media Center.
 - 3. Provide standard performance control in the Competition Gym.

2.19 CABLES – FACTORY TERMINATED – PORTABLE

- A. Factory terminated cable assemblies in this section are approved for portable use only.
- B. Portable cable assembly quantities are identified in parenthesis and are required to be furnished in addition to those required for system installation. Portable cable lengths are a minimum not to exceed the maximum acceptable length identified in the cable descriptions below. Where specific lengths are cited adjacent to quantities, these lengths are to be taken as ideal lengths. If a pre-approved model series is not offered in the specific length cited, then the cable length closest to the cited length shall be provided unless the difference is greater than twenty percent. In this case, contact the Consultant for direction.
- C. All cable assemblies must be factory tested and certified.
- D. Microphone Cable – Microphone cables shall be black with colored boot or ring on the male connector as a color code to identify length (colors as identified for each length below). Custom print “PROJECT NAME” and cover with clear heat shrink tubing approximately 6-inches from the male connector or use custom engraving on the male connector. Microphone cable part numbers are custom products.
- E. Microphone Cable – 15’, fifteen foot microphone extension cable (yellow) (quantity twelve (12) required, (2) for use in Competition Gym; (2) Media Center; (2) Commons; (2) Auxiliary Gym; (4) additional as needed):
 - 1. ProCo AQ-15M4F0PLM; or
 - 2. Whirlwind MKQ15-WSR-YEL.
- F. Microphone Cable – 25’, twenty-five foot microphone extension cable (red)) (quantity twelve (12) required, (2) for use in Competition Gym; (2) Media Center; (2) Commons; (2) Auxiliary Gym; (4) additional as needed):
 - 1. ProCo AQ-25M2F0PLM; or
 - 2. Whirlwind MKQ25-WSR-RED.
- G. Microphone Cable – 50’, fifty foot microphone extension cable (blue) (quantity four (4) required, (1) for use in Competition Gym; (1) Media Center; (1) Commons; (1) Auxiliary Gym):
 - 1. ProCo AQ-50M6F0PLM; or

2. Whirlwind MKQ50-WSR-BLU.
- H. Microphone Cable – 75', seventy-five foot microphone extension cable (green) (quantity three (3) required, (1) for use in Gymnasium; (1) Commons; (1) Auxiliary Gym):
 1. ProCo AQ-75M5F0PLM; or
 2. Whirlwind MKQ75-WSR-GRE.
- I. Microphone Cable – 100', one-hundred-foot microphone extension cable (white) (quantity two (2) required, (1) for use in Competition Gym; (1) Auxiliary Gym):
 1. ProCo AQ-100M9F0PLM; or
 2. Whirlwind MKQ100-WSR-WHI.
- J. Rugged Category 6, 4-pair shielded patch cable, with male Category 6 Neutrik connector on one end, and other end to be terminated to a male Category 6 connector by Division 27 "Telecommunications Requirements for Audio Video Systems" Contractor. (quantity two (2) 25' portable required)
 1. Neutrik NKE6S-*-WOC.
- K. HDMI Cable, version 1.4 or higher compliant, male HDMI to male HDMI, Acceptable lengths: 1'-16' (quantity four (4) 16' required, (1) for use in Competition Gym, (1) Media Center; (1) Commons; (1) Auxiliary Gym):
 1. Comprehensive Pro AV/IT Series; or
 2. Extron HDMI Ultra Series; or
 3. Approved Equal.

2.20 CABLE ADAPTERS – PORTABLE

- A. Video Adapter – HDMI Universal (quantity two (2) required):
 1. Liberty Wire and Cable DL-AR.

2.21 AUDIO INTERFACE EQUIPMENT – PORTABLE

- A. Direct Box – Mono Source, audio musical instrument direct box, line and loudspeaker inputs, ground lift, and transformer balanced XLR output (quantity one (1) required):
 1. ProCo model DB1; or
 2. Whirlwind model IMP2; or
 3. Approved equal.

- B. Multi-Adapter Box - Mic, adapter box that accepts various stereo or mono line level sources and outputs a single, balanced XLR microphone level signal on a cable. Volume control provides between 20dB and 100dB of attenuation (quantity one (1) required):
 - 1. Emtech Electronics, model EJ-8.
- C. MP3 Balancing Adaptor – Mono XLRM 5', 1/8" audio to single XLRM with balancing transformer on XLR, 5' cable (quantity four (4) required, (1) for use in Competition Gym, (1) Media Center; (1) Commons; (1) Auxiliary Gym):
 - 1. Proco IPATCH-5.
- D. MP3 Adaptor – Stereo XLRM 3', 1/8" audio to dual XLRM, no transformer, 3' cable (quantity four (4) required, (1) for use in Competition Gym, (1) Media Center; (1) Commons; (1) Auxiliary Gym):
 - 1. Proco IY-3.

2.22 PORTABLE ACCESSORIES

- A. Stereo Audio Headphones, 75-ohms impedance minimum each receiver, noise-isolating, coiled cord, and 1/4-inch stereo phone plug (quantity one (1) required Competition Gym):
 - 1. AKG HSC-271; or
 - 2. Audio-technica ATH-M40fs; or
 - 3. Sennheiser HD25 SP II.
- B. Work Light, clip-on work light (one required for each equipment rack):
 - 1. Lowell RL-1A; or
 - 2. Middle Atlantic model WL-60; or
 - 3. Hardware store style with small (nominal 6-inch diameter) aluminum reflector, 60-watt "rough service" bulb, and 6-foot cord.
- C. Cable ties (quantity ten (10) ties required):
 - 1. Toleeto Fasteners International Cord Lox 307-C, 1"x7"; or
 - 2. Hosa WTI-148G (pkg of 5); or
 - 3. Rip-Tie EconoWrap Slip-on 1" wide.
- D. Cable Tester, cable tester with ability to test each individual wire in a variety of common cable types. Tests XLR, 1/8", 1/4", speakON, BNC, Ethernet. Furnish batteries for tester (quantity one (1) required):
 - 1. Ebtech 6-in-1 Cable Tester and Greenlee Cable Check – Data Link ID; or

2. Hosa CBT-500; or
 3. Whirlwind MCT-9 and SC48RJ.
- E. AC Power Extension Cord, 3-conductor, #14 AWG, 25-foot long, black (one required).
1. Standard hardware store or home center model.
- F. Cable Guard Strip - Standard Duty, for covering extension cables on floor, to reduce tripping hazard, 5-foot length, sized for 3/4" cable bundle (quantity four (4) required):
1. Wiremold BK1600-5; or
 2. Approved equal.

2.23 STANDBY EQUIPMENT

- A. The following equipment shall be on-hand at the time of system commissioning and system first-use for possible replacement of defective equipment or for field conditions noted. Maintain ownership of this standby equipment. However, if any item of this standby equipment is used to replace defective equipment, the installed item of standby equipment becomes Owner's property. Assume ownership of the defective equipment:
1. Backup software for programmable devices.
 2. Laptop computer for all programmable devices.
- B. Allowances for overnight shipping of critical components should be included and utilized if component failure is essential to Owner's initial operation of the entire audio-video systems or first-use requirements.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS

- A. Refer to Division 27 Section "Audio Video Systems" for common requirements.

3.2 LABELING

- A. Refer to Division 27 Section "Audio Video Systems" for labeling requirements.

END OF SECTION 274116

SECTION 275116 - PUBLIC ADDRESS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish and install all equipment, accessories, and materials in accordance with these specifications and drawings to provide a tested and fully functioning intercom system in the building, including but not limited to:
 - 1. Intercom Head End System
 - 2. Admin Intercom Master Station
 - 3. Media Player
 - 4. Speakers – ceiling and wall mounted, with talk-back functionality initiated by wall-mounted call buttons (Intercom Call-In Switches)
 - 5. Amplifier/Switching Device – a minimum of one located in each Telecom Room, to power classroom ceiling speakers.
 - 6. Paging horn if applicable.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions, requirements, and recommendations in Division 27 Section “General Communications Requirements” and “Common Work Results for Communications”.

1.3 CODES, REFERENCES, AND STANDARDS

- A. Follow all applicable codes, references, and standards listed in Division 27 Section “General Communications Requirements” and “Common Work Results for Communications”.

1.4 GUIDELINES

- A. Follow all applicable guidelines listed in Division 27 Section “General Communications Requirements” and “Common Work Results for Communications”.

1.5 DEFINITIONS

- A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

- B. VU: Volume unit.
- C. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.6 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of public address systems and ancillary equipment of types, ratings, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firms with at least 3 years of successful installation experience with projects utilizing public address systems and equipment similar to that required for this project.
- C. All work shall be performed and completed in a thorough and workmanlike manner and in accordance with the manufacturer's instructions.
- D. All items of equipment including wire and cable shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.
- E. Except where specifically noted otherwise, all equipment supplied shall be the standard product of a single manufacturer of known reputation and experience in the industry. The supplying contractor shall have attended the manufacturer's installation and service school. A certificate of this training shall be provided with the contractor's submittal.
- F. Listing and labeling: Provide products specified in this section that are listed and labeled.
 - 1. The terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.

1.7 REGULATORY REQUIREMENTS

- A. Provide products listed and classified by Underwriter's Laboratories, Inc as suitable for the purpose indicated.
- B. Follow all applicable local codes, references, and standards per the listings in this specification and per the Authority Having Jurisdiction.
- C. The communications system shall bear the label of a Nationally Recognized Testing Laboratory (NRTL) such as D.S.&G. and be listed by their re-examination service. All work must be completed in strict accordance with all applicable electrical codes, including N.E.C. Section 800-51 (i), under direction of a qualified and factory approved distributor, to the approval of the owner.
- D. Comply with UL 50.
- E. Comply with NFPA 70.

1.8 SUBMITTALS

- A. The following submittals are due at the “pre-bid” phase submission:
1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Engineer. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.
- B. The following submittals are due at the “pre-construction” phase submission:
1. Shop Drawings:
 - a. Submit for review scaled layout drawings showing the routing of all cabling, locations of public address devices, console, rack arrangements and splices (where allowed/required by contract documents), pair/strand counts, cable types, cable jacket listing information, fire stop locations (with quantity and NRTL system number identified) and cable designations at each splice and termination point.
 - b. Unless otherwise required by these specifications, it is permissible to show different cabling systems (voice, data, CATV, A/V) on the same shop drawing.
 - c. Shop drawings shall show the layout of the AV equipment racks with each block/ panel.
 2. Provide calculations for sizing backup battery
 3. Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters).
 4. Submit manufacturers’ cut sheets or catalog cut sheets of each of the cables specified not specifically identified by its exact part number:
 - a. Cut sheets shall include the following information at a minimum:
 - 1) Manufacturers name and logo
 - 2) Cable outside diameter
 - 3) Number of conductors/strands in each cable and binder group
 - 4) Gauge or strand thickness
 - 5) Minimum transmission performance rating
 - 6) Cable jacket material and rating
 - 7) Maximum pulling tension
 - 8) Jacket/Sheath color
 - 9) Individual conductor or strand insulation colors
 - 10) Minimum bend radius

- a) During installation and post installation.
 - b) As well as any additional information required by individual sections of this Division.
- 5. Required warranty information as indicated herein and elsewhere in this Division
- 6. Manufacturers Testing
 - a. Submit as required by in the specification sections.
- C. The following submittals are due at the “Project Completion” phase submission:
 - 1. As-built Drawings:
 - a. Submit scaled layout drawings showing the routing of all cabling, locations of speakers, head end equipment, public address devices and splices (where allowed/required by contract documents), pair/strand counts, cable types, cable jacket listing information, fire stop locations (with quantity and NRTL system number identified) and cable designations at each splice and termination point.
 - b. Unless otherwise required by these specifications, it is permissible to show different cabling systems (voice, data, CATV, A/V) on the same As-built drawing.
 - c. As-built drawings shall show the layout of the AV equipment racks with each block/ panel.
 - 2. Installation wiring diagrams and instruction manuals
 - 3. Warranty Certificate
 - 4. Submit a certificate of completion of installation and service training from the system manufacturer.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following
 - 1. Carehawk CH1000 system – Basis of Design
 - 2. Bogen Communications, Inc. – E7000 system
 - 3. Three-Sixty - Galaxy
 - 4. Valcom – Class Connection ES

2.2 HEAD END EQUIPMENT

- A. Main cabinet
- B. Intercom master station
- C. Media player – Integral or Auxiliary

2.3 SOFTWARE

- A. Programming software
- B. Administrative Assistant software

2.4 PERIPHERAL DEVICES

- A. Administration phone / Microphone – quantity of (2)
- B. Switching modules
 - 1. Provide quantities as required to support all Classroom speaker locations. Include minimum 25% spare ports in each Telecom Room for future expansion.
- C. Speakers & Call Stations
 - 1. Indoor ceiling speakers and grilles - 2' x 2' Lay-In Type shall have volume control and rotary wattage adjustment, shall be:
 - a. Quam System 12/VC
 - b. Bogen Model CSD2X2VRU
 - c. Approved equal
 - 2. Indoor wall-mounted speakers shall be:
 - a. Quam System 2
 - b. Bogen Model WBS8T725
 - c. Approved equal
 - 3. Call Buttons:
 - a. Bogen
 - 1) CA-17
 - 2) VRS1 Speaker with integral Call Button

- b. Quam
 - 1) CIB2
 - 2) CIS4 Speaker with integral Call Button
- c. Approved Equal
- 4. Paging Horns:
 - a. Atlas Sound VT series loudspeaker
 - b. Approved Equal
- 5. Wiring shall be done per manufacturer's recommendations and shall utilize plenum-rated Category 5e Speakers that shall be provided with two-way functionality unless in corridors or rooms with multiple speakers where a single speaker is being identified for the return signal.

2.5 GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS

- A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
- B. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
- C. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch (483-mm) housing complying with TIA/EIA-310-D.
- D. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

2.6 EQUIPMENT CABINET

- A. Comply with TIA/EIA-310-D.
- B. House amplifiers and auxiliary equipment at each location.
- C. Cabinet Housing:
 - 1. Constructed of 0.0478-inch (1.2-mm) steel, minimum, with front- and rear-locking doors and standard TIA/EIA-310-D-compliant, 19-inch (483-mm) racks.
 - 2. Arranged for floor or wall mounting as indicated.
 - 3. Sized to house all equipment indicated, plus spare capacity.
 - 4. Include 25 percent minimum spare capacity for future equipment in addition to space required for media player

- D. Power Provisions: A single switch in cabinet shall disconnect cabinet power distribution system and electrical outlets, which shall be uniformly spaced to accommodate ac-power cords for each item of equipment.
- E. Ventilation: A low-noise fan for forced-air cabinet ventilation. Fan shall be equipped with a filtered input vent and shall be connected to operate from 105- to 130-V ac, 60 Hz; separately fused and switched; arranged to be powered when main cabinet power switch is on.

2.7 EQUIPMENT RACK

- A. Racks: 19 inches (483 mm) standard, complying with TIA/EIA-310-D.
- B. Power-Supply Connections: Compatible plugs and receptacles.
- C. Enclosure Panels: Ventilated rear and sides and solid top. Use louvers in panels to ensure adequate ventilation.
- D. Finish: Uniform, baked-enamel factory finish over rust-inhibiting primer.
- E. Power-Control Panel: On front of equipment housing, with master power on-off switch and pilot light; and with socket for 5-A cartridge fuse for rack equipment power.
- F. Service Light: At top rear of rack with an adjacent control switch.
- G. Vertical Plug Strip: Grounded receptacles, 12 inches (300 mm) o.c.; the full height of rack.
- H. Maintenance Receptacles: Duplex convenience outlets supplied independent of vertical plug strip and located in front and bottom rear of rack.
- I. Spare Capacity: 25 percent in rack for future equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install and wire systems and equipment in accordance to the NFPA 70, other applicable codes, and per the local Authority Having Jurisdiction. Install and wire systems and equipment to comply with manufacturer's written instructions.
- B. Wiring Method: Install wiring in raceway in walls and in un-accessible ceiling spaces. In spaces above accessible ceilings, plenum cable may be installed in cable trays or using D-Rings where cable trays are not available. All cabling shall be kept a minimum of 12" from lighting ballasts and 4' from transformers and power equipment.
- C. Control Circuit Wiring: Install control circuits in accordance to NFPA 70 and as indicated per manufacturer's instructions. Provide number of conductors as recommended by system manufacturer to provide the control functions specified.

- D. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes, terminal cabinets, and equipment enclosures.
- E. Wiring Within Enclosures: Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.
- F. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
- G. Provide physical isolation from each other for microphone, line level, speaker, and power wiring. Run in separate raceways or provide 12 inches of minimum separation where exposed or in same enclosure. Provide additional physical separation as recommended by equipment manufacturer.
- H. Conductor Requirement and Sizing: Size all conductors per manufacturer's recommendations.
- I. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
- J. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings as recommended by the Manufacturer.
- K. Grounding: Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common mode returns, noise pickup, cross-talk, and other impairments. Ground equipment per manufacturer's recommendations.
- L. Repairs: Wherever walls, ceilings, floors, or other building finishes are cut for installation - repair, restore, and refinish to the original appearance
- M. Cleaning: Prior to final acceptance, clean system components and protect from damage and deterioration.
- N. Firestopping: All holes, conduit penetrations, etc., shall be firestopped to meet applicable codes. Penetrations shall be made using conduit sleeves.
- O. All outside speakers shall be on a separate zone.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: If installing contractor is not already a factory-authorized service representative, engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. 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.
- C. Tests and Inspections:
 - 1. Schedule tests with at least seven days' advance notice of test performance.

2. After installing public address and after electrical circuitry has been energized, test for compliance with requirements.
 3. Cable Test: Contractor shall provide a thorough testing program for the cabling system. The testing should be done in accordance with EIA/TIA TSB-67, Level II performance. All cables shall be tested.
 4. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
 5. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
 - a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
 - b. Repeat test for each separately controlled zone of loudspeakers.
 - c. Minimum acceptance ratio is 50 dB.
 6. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
 7. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
- D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.
- E. Public address systems will be considered defective if they do not pass all tests and inspections.
- F. Prepare test and inspection reports.
1. Include a record of cable testing, final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

3.3 STARTUP SERVICE

- A. Perform startup service.
1. Verify that wiring installation complies with manufacturer's submittal and installation requirements.

2. Complete installation and startup checks according to manufacturer's written instructions.

3.4 ADJUSTING

- A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain the public address and mass notification systems and equipment in all operating modes and functions.
- B. Schedule training with owner with at least seven (7) days advanced notice.
- C. Provide a minimum of four (4) hours of training.

3.6 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: When requested within one (1) year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, adjusting controls, and investigating possible needs for any system revisions required to meet actual occupancy conditions. Provide up one (1) visit to the site for this purpose.

3.7 WARRANTY

- A. The contractor shall warrant parts and labor for the complete system wiring and equipment to be free from inherent mechanical and electrical defects for a period of one (1) year.

END OF SECTION 275116

SECTION 275313 - WIRELESS CLOCK SYSTEM

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. Provide a complete wireless clock system, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate the system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and coordination/registration of an FCC license.
- B. System Description
 - 1. System shall continually wirelessly synchronize clocks and/or timers, and shall be capable of clock readouts in multiple time zones where desired.
 - 2. System shall operate on a 72MHz frequency. The 72MHz frequency transmitter efficiently sends time synchronization signals through commercial building materials to ensure all devices receive important time updates, even for Daylight Saving Time and after a power outage.
 - 3. The system transmitters can be configured with a variety of power output levels to provide coverage for a single building or an entire campus.
 - 4. The system supports an FCC license for operation of a 72MHz transmitter result in safe and interference free operation for users.
 - 5. System shall provide wireless time from a master time source. This time source will either be the atomic clock on the GPS system or the clock from a defined NTP server that the XR transmitter can access via the customer Local Area Network (LAN). The master time will be synchronized to UTC.
 - 6. Hard wiring for data communication will not be required to the clocks installed for the system.
 - 7. Clocks shall automatically adjust for Daylight Saving Time in locations where DST is observed.
 - 8. Each clock and/or timer and every other component in the system shall use both precise time and synchronized time.
 - 9. Digital clocks shall be synchronized to within 10 milliseconds every 10 minutes and the system shall have an internal oscillator that maintains plus or minus four seconds per day between synchronization, so that clock accuracy shall not exceed plus or minus 0.2 seconds.
 - 10. Analog Clocks shall be synchronized to within 10 milliseconds 6 times per day when operating clock strikes 2:01 AM, 6:01 AM, 10:01 AM, 2:01 PM, 6:01 PM, and 10:01 PM, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronization, so that clock accuracy shall not exceed plus or minus 0.2 seconds.

11. The system shall include an internal clock reference so that failure to detect the master time source shall not result in the clocks failing to indicate time. Additionally, XR transmitters will have an internal battery backup of up to eight hours in the event of a power failure so that settings and the correct master time will be instantly recalled upon restoration of power.
12. System shall incorporate a “fail-safe” design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal operation without the need to reset the system or any component thereof.
13. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded. If signal transmission is not restored after 48 hours, the second hand will “five step” as a visual indicator that the signal has been lost. Should the clocks lose power and signal, the clocks will not function.
14. Clock locations shall be as indicated and clocks shall be fully portable, capable of being relocated at any time.
15. System shall operate in accordance with a “Radio Station Authorization”, Form FCC 601 – LM, granted by the Federal Communications Commission (FCC). This license will be issued to and held by the end user.

C. System Components:

1. Transmitter (Master)
2. Satellite Transmitter
3. GPS Receiver
4. System Devices:
 - a. Analog Clocks
 - b. Digital Clocks

1.2 RELATED DOCUMENTS

- A. Division 27 Section “General Communications Requirements” details general requirements that work under this section shall follow.
- B. Division 27 Section “Common Work Results for Communications” details general grounding and bonding, pathways, firestopping, access panel, and identification requirements that work under this section shall follow.

1.3 CODES, REFERENCES AND STANDARDS

- A. All material, manufacturing methods, handling, dimensions, methods of installation and test procedures shall conform to industry standards, acts, and codes, including, but not limited to:

1. The full list of Codes, References, and Standards in Division 27 “General Communications Requirements”.

1.4 DEFINITIONS

- A. GPS: Global Positioning System, a worldwide system that employs a constellation of satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits Universal Coordinated Time, the world’s most accurate and reliable time.
- B. NTP: Network Time Protocol, used for synchronizing the clocks on computer networks and devices from either a public server or a separate server on a private local area network.
- C. PoE: Power-over-Ethernet
- D. UTC: Universal Coordinated Time

1.5 REGULATORY REQUIREMENTS

- A. Equipment and components furnished shall be of manufacturer latest model.
- B. System shall be installed in compliance with local and state authorities having jurisdiction.
- C. U.S. only: The end user will hold a license, known as a “Radio Station Authorization” granted by the FCC. This license grants the end user protected use for wireless transmission at the designated frequency. This license will designate a unique “call sign” for each end user.
- D. U.S. only: Transmitter and receiver shall comply with Part 90 of FCC rules as follows: This device may not cause harmful interference. This device shall accept interference received, including interference that may cause undesired operation. Transmitter frequency shall be governed by FCC Part 90.35. Transmitter output power shall be governed by FCC Part 90 257 (b).

1.6 QUALITY ASSURANCE

- A. Warranty
 1. Refer to Division 27 section “General Communications Requirements” for standard one year warranty requirements from date of Substantial Completion.
 2. Include a 3-year, extended warranty from the clock system manufacturer, which shall include all parts and labor for the duration of the warranty.

1.7 SUBMITTALS

- A. Follow the requirements for submittals in Division 27 Section “General Communications Requirements”.

B. The following submittals are due at the “pre-bid” phase submission:

1. Alternate manufacturers or system for approval

C. The following submittals are due at the “pre-construction” phase submission:

1. Parts List (Bill-of-Materials): Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters).
2. Submit manufacturers’ cut sheets or catalog cut sheets:
 - a. Cut sheets shall include the following information at a minimum:
 - 1) Manufacturers name and logo
 - 2) Product to be installed, with specific product highlighted or otherwise indicated.
 - 3) Size – including physical and loading dimensions.
3. Operating License (US only): Submit evidence of application for FCC Radio Station Authorization prior to installing equipment. Furnish the license or a copy of the application for the license, to the Owner/End User prior to operating the equipment. The original license shall be delivered to the Owner/End User.
4. Shop Drawings:
 - a. In accordance with Division 27 Section “Common Work Results for Communications”, submit for review scaled layout drawings showing:
 - 1) the size/routing of all pathways
 - 2) the size/information/locations of all boxes, pullboxes, firestopping systems, and access panels.
 - 3) Identify submittal as “Common Work for Clock Systems - Shop Drawings”, unless combined with other Common Work in Division 27.
 - b. Submit for review as part of “275313 Clock System - Shop Drawings”:
 - 1) Riser diagram of Clock System
 - 2) Scaled layout drawings showing system components:
 - a) Antenna location(s)
 - b) Cable routing, with cable type identified
 - c) Clock types/locations
 - d) Active/Headend equipment locations

D. The following submittals are due at the “Project Completion” phase submission:

1. Record Drawings:
 - a. Based on the work prints kept on the jobsite and official changes to the Contract Documents (such as Change Orders, Architect's Supplemental Instructions, and Design Change Directives), create final drawings incorporating any minor and approved changes to the submitted Shop Drawings. Submit this set in accordance with the Record Drawings requirements of Division 27 Section “General Communications Requirements”.
2. Operation and Maintenance Manuals, to include:
 - a. Bill-of-Materials (updated, if necessary)
 - b. Manufacturer cutsheets of all products
 - c. Operation and Maintenance Manuals of all products
3. Operating License: FCC Radio Station Authorization
4. Training / Instruction of Owner on the use and programming of the system.

1.8 COORDINATION

- A. Clocks and/or Timers shall not be installed until painting and other finish work in each room is complete.
- B. Programmable Count Down Timers: a computer having the specified minimum system requirements for the scheduling software installation will be available for use in programming the timer. Coordinate with Owner during construction.
- C. Transmitter - External Antenna: Coordinate installation of system antenna for access to the roof to comply with safety standards detailed in manufacturer instructions and per local codes.
- D. For Network Time Protocol, coordinate with Owner's IT Representative.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

- A. With the exception of cabling, all products of the Clock System shall be from the same manufacturer, unless otherwise noted.
- B. Master Time Source Operation
 1. NTP Time Source: With the transmitter in NTP mode, it connects over the Ethernet to the IP address of the NTP server. This IP address is programmed into the transmitter as part of its configuration. Once the connection to the NTP server is acknowledged, it downloads time data and synchronizes its internal master clock to NTP time. The transmitter then starts to transmit its

internal time once every second. The transmitter updates its internal clock in this mode once per hour.

C. The following manufacturers are conditionally approved:

1. Primex Wireless
2. Sapling Clocks
3. Approved equivalent, submitted prior to bid in accordance with Division 27 section "General Communications Requirements".

2.2 TRANSMITTER EQUIPMENT

A. 1 Watt Transmitter

1. The transmitter shall meet all of the below specifications:
 - a. Transmission Frequency Ranges – 72.020 to 72.980 MHz
 - b. Maximum transmission: 1 watt (30dBm) maximum at transmitter
 - c. Operating Range: 32°F - 122°F (0° - 50°C)
 - d. Power: 120 VAC 60 Hz
 - e. Internal Antenna
 - f. Channels:
 - 1) 16 selectable channels
 - g. Time Source:
 - 1) Transmitter will allow for either NTP time input or GPS satellite time input with use of a GPS Receiver unit.
 - 2) Unit shall obtain current time from either satellite via GPS or via NTP through an Ethernet port.
2. Internal Antenna Model only: Transmitter shall transmit time continuously to all clocks in the system.
3. Internal clock: Transmitter shall contain an internal clock such that failure to update time from source will not disable the operation of the clocks.
4. Transmitter shall include a surge suppressor/battery backup and a mounting shelf.
5. Transmitter shall have the following switches

- a. Time zone adjustment switches for all time zones in the world. Includes: Eastern, Central, Mountain, Pacific, Alaska, and Hawaii.
 - b. Switch to allow the following configuration: Daylight Saving Time bypass option, 12-hour or 24-hour display, GPS or NTP time source, Local or LAN configuration, UTC+ or UTC-, 30 minute UTC offset option CANADA (for Newfoundland).
6. Transmitter housing shall incorporate a display, which shall include the following:
 - a. Time readout
 - b. AM and PM indicator if 12-hour time display is set
 - c. Day and date readout
 - d. Time zone indicator including Standard or Daylight Savings Time
 - e. On screen menu to verify diagnostics, errors, time updates, and switch settings, toggled by sequence of push buttons next to display.
 - f. Status LEDs: The LED signal indicator consists of three visual LEDs that indicate the status of the transmitter. The green LED indicates one of the three statuses, including (1) solid green: transmitter is transmitting, (2) not illuminated: transmitter has not received an initial time signal after power up and/or reset, and (3) flashing: transmitter is not broadcasting due to standby mode or there is a condition that is causing the transmitter not to broadcast properly. The yellow LED indicates one of the two statuses, including (1) not illuminated: no warning conditions, (2) flashing: transmitter has not received a time update for 48 hours or a 1PPS (one pulse per second) has not been detected within the last 48 hours. The red LED indicates one status, (1) solid red: defined error condition exists.
7. Install in Main Telecommunications Room.
8. Manufacturer shall be:
 - a. For coverage up to 100,000 sq. ft., on average: Primex Wireless – 1-Watt Transmitter – Internal Antenna 16-channel – 14000 Series
 - b. Or equivalent from Sapling

2.3 SOFTWARE

- A. Software shall be compatible with the following PC operating systems: Windows XP, Windows Vista, Windows 7.
- B. Owner will provide access to a PC with valid administrator rights. Install the software and program the Clock System per Owner's direction. Program system in the presence of Owner's representative and provide instruction/training.
- C. A copy of the software shall be provided from manufacturer in a form of a CD, suitable for operation in standard CD-ROM drives.

2.4 ANALOG CLOCKS

- A. Analog clocks shall be wall mounted, as indicated on the drawings.
- B. Face shall be white. Hour and minute hands shall be black.
 - 1. Additional colors, finishes, and dial faces are available from manufacturer.
 - 2. Clock faces can be customized by manufacturer to display organization name or logo if desired by owner or architect.
- C. Clock frames and lenses are of durable thermoplastic.
- D. Size and frame color shall be:
 - 1. Standard Battery Models 12.5" black
- E. Provide optional wire guard accessory where clocks are susceptible to accidental damage, including, but not limited to:
 - 1. Gymnasiums
- F. Analog clocks shall be capable of automatically adjusting for Daylight Saving Time. An on-off switch located on the transmitter shall disable this function if desired.
- G. Clock shall have a battery-power power supply built into the clock assembly.
 - 1. If power is interrupted, the clock will stop until power resumes. Upon resumption of power, the clock will self-correct to the current time.
 - 2. Battery-operated analog clocks shall have up to a 5-year battery life.
 - 3. Installer will furnish clock batteries in accordance with manufacturer instructions.
 - 4. Battery-operated analog clocks shall remember the time during changing of batteries.
- H. Time shall be automatically updated from the transmitter 6 times per day.
- I. If the transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded. If signal transmission is not restored after 96 hours, the second hand will “five -step” as a visual indicator that the signal has been lost. Should the clocks lose power and signal, the clocks will not function.
- J. Analog clock receivers shall be as follows:
 - 1. Receiver sensitivity: >-110 dBm,
 - 2. Antenna type: internal, Antenna gain: -7 dBd
- K. Manufacturer shall be:

1. Primex Wireless
2. Sapling

2.5 DIGITAL CLOCKS

- A. Digital Clocks shall be able to receive synchronized time signal from the master or satellite transmitter.
- B. Digital Clock display shall include a 12 or 24-hour time display, a PM indicator light, and an alternating time and date display option.
- C. Digital Clock shall be capable of automatically adjusting for Daylight Saving Time.
- D. Digital Clock shall have either a 120 VAC power supply built into the clock assembly.
 1. 120 VAC Digital Timer shall include a 9-foot power cord (minimum) with a three prong plug or a 18" (45.72cm) cord with pigtail.
- E. Digital clocks shall be viewable from 150 feet.
- F. Digital clocks shall have highly visible 7-segment LED digits.
- G. Digital clock shall have three display dimmer options, 75%, 50%, and 25%.
- H. Model shall be dual-mount with 2.5 inch tall digits:
 1. Ceiling - 18" cord with pigtail, 120 VAC

PART 3 - EXECUTION

3.1 GENERAL

- A. All conduit routing and junction boxes for the Clock System shall be accurately identified on shop drawings and final record drawings. Refer to Division 27 Section "Common Work Results for Communication" for additional requirements.
- B. Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.
- C. Verify that 120 volt electrical outlet is located within 6 feet (1.83m) of location of transmitter and the outlet is operational and properly grounded.
- D. AC-powered devices: Verify that electrical power outlet is near location of clock or timer and the outlet is operational and properly grounded.
- E. Install system in accordance with applicable codes.
- F. Install system equipment in accordance with manufacturer written instructions.

- G. Provide all system equipment necessary for a complete and operable system.

3.2 MASTER TIME SOURCE – NTP

- A. Connect CAT5e/CAT6 EIA/TIA standard Ethernet cable from transmitter LAN port to available network drop.
 - 1. The network drop used to connect the XR transmitter shall have connectivity to the NTP server, which can be verified by the owner's Information Technology department manager. The default NTP address is time.nist.gov. If the network has a different NTP IP address, it shall be programmed into the transmitter by the installer to allow connection to the proper network time.
- B. Set GPS/LAN DIP switch to NTP.

3.3 TRANSMITTER – INTERNAL ANTENNA

- A. Locate transmitter where indicated, a minimum of 2 to 3 feet above the floor, away from large metal objects such as filing cabinets, lockers or metal framed walls.
- B. Transmitter(s) shall be placed at locations indicated within specifications and drawings.
- C. Connect antenna to transmitter, using care not to strip threads.
- D. Connect power supply to the transmitter.
- E. Set the channel number on the display to correspond to the FCC license.
- F. Plug power supply into electrical outlet.

3.4 ANALOG CLOCKS

- A. Furnish all equipment necessary for a complete and operational system.
- B. Perform the following operations with each clock:
 - 1. Configure and set clock to correct time in accordance with manufacturer's instructions.
 - 2. Observe clock until valid signals are received and clock adjusts itself to correct time.
 - 3. Install each clock per its model mounting specifications per manufacturer instructions and mounting instructions at the indicated location.

3.5 DIGITAL CLOCKS

- A. Cable routing shall comply with TIA-569-B and local building codes.
- B. Furnish all equipment necessary for a complete and operational system.

C. Perform the following operations with each clock:

1. Configure and set clock to correct time in accordance with manufacturer's instructions.
2. Observe clock until valid signals are received and clock adjusts itself to correct time.
3. Install each clock per its model mounting specifications per manufacturer instructions and mounting instructions at the indicated location.

3.6 WIRE GUARDS

- A. Secure to wall, using approved theft-resistant fasteners.

3.7 LABELING

- A. Submit proposed labeling scheme for transmitter(s), clocks, and cabling, identifying each component and label on the shop drawings.
- B. All cables shall be labeled within 6" of each end.
- C. Where applicable, label back of each clock with accepted identification/label.
- D. Label cover of any junction box utilized for clock system conduit/cabling with "Clock System J-Box".

3.8 COMMISSIONING/TESTING

- A. Prior to final acceptance, inspect each system device and component, adjust as required, and replace parts which are found defective. Also, clean exposed surfaces of devices, using cleaning methods recommended by manufacturer.
- B. All devices shall be tested at their operational location under normal operational conditions to assure reception of signal.
- C. Protect finished installation until final acceptance of the project.

3.9 TRAINING

- A. Provide training to Owner's representative on setting, adjusting and configuring device and routine maintenance.
- B. Provide training to Owner's representative on installing the software, adjusting and programming the transmitter, setting and adjusting system devices and routine maintenance.

3.10 PROJECT COMPLETION – CLOSE OUT DOCUMENTS

- A. Provide “Project Completion” submittal requirements as outlined in Division 27 Section “General Communications Requirements” and the submittal requirements earlier in this section.

END OF SECTION 275313

SECTION 280501 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. This Section includes general construction materials and methods, electronic security equipment coordination, and common Electronic Security Systems installation requirements as follows:
 - 1. Pathways
 - a. Conduit
 - b. Outlet Boxes
 - c. Pull Boxes
 - 2. Grounding and Bonding
 - 3. Firestopping Systems
 - 4. Access Panels
 - 5. Identification
- B. *Note* Refer to Division 28 Section “Common Work Results for Fire Alarm Systems” for common work requirements for fire alarm systems. This section specifies the common work requirements of all other Division 28 sections.

1.2 RELATED SECTIONS

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Division 28 Section “General Electronic Safety and Security Requirements”
- B. Firestopping requirements listed in this section are unique to Division 28 Work. Refer to Division 07 Section “Penetration Firestopping” for general and additional firestopping requirements.
- C. Refer to Division 26 for materials and methods for additional requirements for the following:
 - 1. Division 26 Section “Common Work Results for Electrical” for electrical systems coordination.
 - 2. Division 26 Section “Equipment Wiring Systems” for electrical systems coordination.
 - 3. Division 26 Section “Grounding and Bonding for electrical systems” for electrical systems coordination.

4. Division 26 Section “Hangers and Supports for Electrical Systems” for electrical systems coordination.
5. Division 26 Section “Raceways and Boxes for Electrical System” for electrical systems coordination.
6. Division 26 Section “Cable Tray” electrical systems coordination.
7. Division 26 Section “Underfloor Raceways for Electrical Systems” electrical systems coordination.
8. Division 26 Section “Underground Ducts and Raceways for Electrical Systems” for electrical systems coordination.

1.3 CODES, STANDARDS, AND GUIDELINES

- A. Follow all applicable codes, references, and standards listed in Division 28 Section “General Electronic Safety and Security Requirements”.
- B. Follow all guidelines listed in Division 28 Section “General Electronic Safety and Security Requirements”.
- C. Follow the correct revision or printing (UON) of all applicable codes, references, standards, and guidelines.
- D. Follow the additional codes, references, standards and guidelines:
 1. Follow the additional codes, references, standards and guidelines:
 - a. For Telecommunications Infrastructure (Category 5e/6/6A and fiber optic cabling) required by this division:
 - 1) ANSI/TIA/EIA-569-C – “Commercial Building Standard for Telecommunications Pathways and Spaces”
 - b. For Firestopping installed by this division:
 - 1) ASTM E 814 and ANSI/UL1479 – “Fire Tests Through Penetration Firestops”
 - 2) ASTM E 84 and ANSI/UL 723 “Surface Burning Characteristics of Building Materials”
 - 3) ASTM E 119 and ANSI/UL 263 “Fire Tests of Building Construction Materials”

1.4 QUALITY ASSURANCE

- A. Install all Work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.

B. Firestopping Systems

1. Firestopping material and systems shall be tested and listed by UL. All firestopping products shall bear this classification marking.
2. Installation technicians shall be by qualified and trained personnel. Acceptable installer qualifications are as follows:
 - a. FM Research, approved in accordance with FM AS 4991.
 - b. Individuals who are trained and certified by the firestopping manufacturer. For Specified Technologies, all installers shall have current FIT Level 1 certification.

1.5 SUBMITTALS

- A. Follow the requirements for submittals in Division 28 Section “General Electronic Safety and Security Requirements”.
- B. The following submittals are due as part of the Pre-Bid Submittal:
 1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution, provide submittals with sufficient detail for review by the Design Consultant. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information. Be prepared to submit a sample should the Design Consultant request an evaluation.
- C. The following submittals are due at the Pre-Construction Submittal:
 1. Contractor Qualifications (for Firestopping Systems): Provide copies of training/certification as required in the Quality Assurance portion of this specification section.
 2. Parts List: Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters).
 3. Submit manufacturers’ cut sheets or catalog cut sheets of each of the pathways not specifically identified by its exact part number:
 - a. Cut sheets shall include the following information at a minimum:
 - 1) Manufacturers name and logo
 - 2) Size – including physical and loading dimensions
 - 3) Maximum span length
 - 4) Weight supported
 - 5) Type
 - 6) Fittings to be used

- 7) Method of attachment to structure
- 8) Firestop system assembly information for each system to be installed:
 - a) Documentation from UL catalog for each system proposed. This documentation shall include the following information:
 - i) Firestop manufacturer
 - ii) UL system number
 - iii) F, T, and L Ratings
 - iv) The complete description of the firestop system; To include what specific construction the system is intended to pass through such as a wall or floor assembly, the penetrating items allowed to pass through the opening in the wall or floor assembly, and the materials designed to prevent the spread of fire through the openings.

4. Shop Drawings:

- a. Submit for review scaled layout drawings showing the size/routing of all pathways and the size/information/locations of all boxes, pullboxes, firestopping systems, and access panels.
 - 1) Each pathway shall be identified by type and size on the drawings.
 - a) Example #1: 4" EMT
 - b) Example #2: 2" IMC
 - 2) Each grounding conductor shall be identified by size (and insulation):
 - a) Example: #3/0 insulated ground
 - 3) Each firestop system shall be identified by Manufacturer and Product, as well as UL system number for that particular location.
 - a) Example #1 – Firestopping Sleeve: EZ-Path Series 22, UL System W-L-3255
 - b) Example #2 – Backbox in Fire-Rated Wall: Specseal Power Shield, UL System QCSN/CLIV.R14288
 - 4) Each pullbox and access panel shall be identified by size and height above finished floor.
 - a) Pullbox Example: Pullbox 8" x 24" x 40" approximately 12' AFF.
- b. Include pathway systems (conduit, cable tray, auxiliary supports, etc.) and other common work on the same shop drawings for Division 28 "Electronic Security Systems".
 - 1) The following submittals are due at the Project Completion Submittal:

a) Record Drawings:

- i) Based on the work prints kept on the jobsite and official changes to the Contract Documents (such as Change Orders, Architect's Supplemental Instructions, and Design Change Directives), create final drawings incorporating any minor and approved changes to the submitted Shop Drawings. Submit this set in accordance with the Record Drawings requirements of Division 28 Section "General Electronic Safety and Security Requirements".

- b) Keys – Supply two copies of every key as required for pullboxes, junction boxes, and access panels.

1.6 DEFINITIONS

- A. Conditionally Approved - the manufacturer has been found reputable by the Design Consultant, but the Design Consultant has not verified that the product offering by manufacturer meets to all specification and project requirements. Contractor shall adhere to submittal review process for final approval on products.
- B. Conveniently Accessible – Capable of being reached from the floor or via the use of an 6 to 12 foot step ladder without crawling or climbing over or under obstacles such as piping, duct work, motors, transformers, pumps, etc.
- C. Firestopping System – Firestopping products that have been specifically tested and rated by a Nationally Recognized Testing Laboratory (NRTL), such as UL, to provide the required flame (F), fire and temperature (T), air and smoke (L), and water (W) containment for a given partition/penetration.
- D. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.
- E. IMC – Intermediate Metal Conduit
- F. Plenum – A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
- G. Plenum-rated – A product that is listed by a NRTL as being suitable for installation into a plenum space.
- H. RMC – Rigid Metal Conduit
- I. Surface Metal Raceway – A metallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.
- J. Surface Nonmetallic Raceway – A nonmetallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.
- K. UL – Underwriters Laboratory

1.7 COORDINATION

- A. Coordinate arrangement, mounting, and support of equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping, ducts, and other systems installed at required slopes and/or elevations.
 - 4. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.
 - 5. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.
 - a. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
 - b. Provide offsets, transitions and changes in direction of conduit* as required to maintain proper headroom and pitch on sloping lines. *Refer to Part 3 of this section for stringent conduit bend requirements.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for Division 28 equipment that are behind finished surfaces or otherwise concealed.
- D. Coordinate testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS AND MATERIALS

2.1 PATHWAYS FOR ELECTRONIC SECURITY SYSTEMS

- A. General
 - 1. Category 6 and fiber cabling and pathways between Equipment Rooms (shared Communications Rooms) and devices are by Division 27.
 - 2. All other cabling serving Electronic Security System devices within the footprint of the building shall meet the following requirements (from device to Equipment Room):

- a. Within concealed conduit from device to overhead ceiling.
 - b. For areas above accessible ceilings, supported via J-hooks every 48"-60" back to nearest cable tray or serving Equipment Room. For inaccessible ceilings or ceilings exposed to structure, continue routing cable within conduit.
3. Division 28 "Electronic Security Systems" Contractor is to indicate proposed pathway types/supports and routing on Division 281000 Shop Drawings.

B. Conduit

1. The following manufacturers are Conditionally Approved.

- a. Metal Conduit and Tubing

- 1) AFC Cable Systems www.afcweb.com
- 2) Anaconda/Anamet www.anacondasealtite.com
- 3) AtKore/Allied Tube & Conduit www.atkore.com
- 4) Electri-Flex Co. www.electriflex.com
- 5) Emerson/O-Z Gedney www.emersonindustrial.com
- 6) Sapa/Indalex www.sapagroup.com
- 7) Southwire/Alflex www.southwire.com
- 8) Wheatland Tube Co. www.wheatland.com
- 9) Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

- b. Nonmetallic Raceway and Tubing

- 1) AFC Cable Systems www.afcweb.com
- 2) Anaconda/Anamet www.anacondasealtite.com
- 3) AtKore/Allied Tube & Conduit www.atkore.com
- 4) Cantex Inc. www.cantexinc.com
- 5) CertainTeed www.certainteed.com
- 6) Condux www.condux.com
- 7) Duraline www.duraline.com
- 8) Electri-Flex Co. www.electriflex.com
- 9) Superflex Ltd. www.superflex.com

- ### C. Outlet Boxes

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- a. Emerson/Appleton
 - b. Hubbell/RACO
 - c. Randl Industries
 - d. Thomas & Betts/Steel City
 - e. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)
2. Specifications
- a. Boxes shall either be square or rectangular, as noted on the drawings. Dimensions indicate minimum size.
 - b. For masonry (CMU) walls, backbox shall be 3-1/2 inches deep. Manufacturer shall be:
 - 1) Single gang – RACO 695R, no substitutes
 - 2) Double gang – RACO 696R, no substitutes
 - c. For stud walls, backbox shall be 2-3/4 inches deep. Manufacturer shall be:
 - 1) Single gang – RACO 560 series, or equivalent from Conditionally approved manufacturer.
 - d. Telecommunications Boxes for Security – for camera outlets shown on TN drawings:
 - 1) For stud walls: dual-gang outlet box shall be a minimum size of 4-11/16 inches width by 4-11/16 inches height by 2-1/8 inches depth, with a dual-gang or single-gang raised cover/extension as needed for flush mounting. Depth shall match that of wall gypsum board(s).
 - a) Double gang – RACO 258/259 (Coordinate knock-out size with conduit size indicated on drawings), RANDL T-55017 or equivalent with appropriate
 - 2) For ceilings (flush or above accessible ceiling): plenum-rated, dual-gang outlet box shall be a minimum size of 4 inches width by 4 inches height by 2-1/8 inches depth, with a dual-gang or single-gang raised cover/extension ring as needed for flush mounting. Depth shall match thickness of gypsum ceiling board(s) or accessible ceiling panel (if applicable).
 - a) Double gang – RACO 239 or equivalent, with ceiling grid framing where installed in accessible ceiling.
 - e. Junction Box – in accessible ceiling space above access controlled doors
 - 1) Minimum Size 6” x 6” x 4” deep, or as noted on drawings/details, with hinged cover
 - 2) NEMA 1 rating

- 3) Manufacturer shall be Hoffman A6N64 (or larger) or equivalent from Conditionally approved manufacturer.
- f. Pull Boxes - for interior use only, mounted in Conveniently Accessible Locations.
 - 1) Specifications
 - a) NEMA 1
 - b) Refer to Execution section for sizing requirements.
 - 2) The following manufacturers are Conditionally Approved.
 - a) Hoffman
 - b) NEMA Enclosures
 - c) Wiegmann
 - d) Or Equivalent

2.2 GROUNDING AND BONDING

- A. Refer to drawings and Division 28 Section “Equipment Room Fittings for Electronic Security” for exact grounding and bonding requirements.

2.3 FIRESTOPPING SYSTEMS

A. General

- 1. The following manufacturers are Conditionally Approved.
 - a. 3M
 - b. Hilti
 - c. Specified Technologies, Inc
- 2. Division 28 “Electronic Security Systems” Contractor is to indicate proposed Firestopping locations that correspond to their proposed pathway and cable routing on Division 281000 Shop Drawings.
- 3. Refer to Architecture / Life Safety plans for locations of fire- and smoke-rated walls.

B. Fire-Rated Pathway Device – for sleeves through a single penetration (wall or floor)

- 1. Specifications

- a. Minimum performance requirements: Shall meet testing requirements of ASTM E-814 or U.L. 1479; Shall be installed in accordance with the NRTL. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
 - b. Shall meet or exceed the ratings of the wall or floor that it penetrates.
 - c. Shall be a pre-fabricated and zero-maintenance solution which requires no action to activate the fire and smoke protective characteristics of the device.
 - d. Allows the installation and removal of cables without the need to remove or add any materials.
 - e. Used to seal penetrations of cables through fire rated partitions
 - 2. Manufacturer shall be:
 - a. EZ-Path family of products by Specified Technologies Inc.
 - b. SpeedSleeve series of products by Hilti
 - c. Or approved equivalent
- C. Firestopping for Backboxes in Fire-Rated Walls
- 1. Specifications
 - a. Used to seal backboxes in fire rated partitions.
 - b. Minimum performance requirements: Shall meet UL testing requirements of UL 263 and classified as Wall Opening Protective Material (QCSN or CLIV); Shall be installed in accordance with the NRTL. Shall meet or exceed the ratings of the wall or floor that it is located in.
 - c. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
 - 2. Manufacturer shall be:
 - a. Specified Technologies Inc., SpecSeal Power Shield
 - b. Or approved equivalent
- D. Firestopping for Thru-Wall (or Floor) Conduit Penetrations and Other Applications
- 1. For fire-rated penetrations where the pathway extends beyond a single fire-rated partition, and other required firestopping applications not previously addressed in this specification.
 - 2. Specifications:
 - a. Shall be UL listed for the specific application; Shall meet or exceed the ratings of the wall or floor that it penetrates.

3. Manufacturer shall be:
 - a. Specified Technologies Inc.
 - b. Or approved equivalent

2.4 ACCESS PANELS

A. The following manufacturers are Conditionally Approved.

1. Activar/J.L Industries www.activarcpg.com
2. Acudor Products www.acudor.com
3. Alfab/Barco www.alfabinc.com
4. Elmdor Products www.elmdorproducts.com
5. Karp Associates, Inc. www.karpinc.com
6. Milcor www.commercialproductsgroup.com
7. Nystrom Building Products www.nystrom.com
8. Williams Brothers www.wbdoors.com
9. Wind-lock www.wind-lock.com
10. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)

B. Specifications:

1. To be utilized for access to a Pull Box that is installed above an inaccessible ceiling (where a Pull Box is required to keep the number of bends in conduit to 180 degrees or less between pull points).
2. Steel Access Panels and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation.
3. Joints and seams: continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
4. Frames: 16-gauge steel, with a 1 inch (25.4 mm) wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling:
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
 - b. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - c. For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

5. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
6. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

C. Locking Devices:

1. Wherever these are located in a publically accessible space and are less than 9' AFF, provide a lock.
2. Lock shall be 5-pin or 5-disc type cylinder locks, individually keyed.
3. Provide 2 keys.

- D. Indicate proposed size and locations on pre-construction shop drawings. No access panels shall be installed without Architect and Design Consultant approval.

2.5 FASTENINGS

- A. Except in equipment rooms, all exposed securing screws shall be stainless steel, center pin torx security screws. Security Fasteners: A maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Holo-Krome; a Danaher Corporation.
 2. Safety Socket Screw Corporation.
 3. Tamper-Pruf Screws, Inc.
 4. Textron Inc.

2.6 IDENTIFICATION FOR COMMON WORK FOR ELECTRONIC SECURITY SYSTEMS

A. Labels

1. The following manufacturers are Conditionally Approved for generic labeling requirements for conduits, pullboxes, and equipment racks.
 - a. Brady www.bradycorp.com
 - b. Brother www.brother-usa.com
 - c. Dymo www.dymo.com
 - d. HellermannTyton www.hellermannntyton.com
 - e. Panduit www.panduit.com

- f. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)
- 2. Specifications:
 - a. Refer to additional requirements in Part 3 – Execution.
 - b. Refer to individual sections for additional identification requirements for specific work.

PART 3 - EXECUTION

3.1 PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

A. General

- 1. Refer to Electrical Division 26 for specific installation requirements.
 - a. Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.
- 2. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- 3. All supports shall be specifically designed to support the required cable weight and volume. Field manufactured supports will not be accepted.
- 4. Install a pull cord in each pathway (empty or not) for installation of new wires or cables. Use polypropylene or monofilament plastic line with not less than 200 lb (90.7 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
- 5. Unless otherwise noted, pathway routing shown on the Drawings is illustrative only and meant to indicate the general configuration of the work. Install pathways so that adequate clearances and offsets between pathways and other trades are provided. Coordinate all pathways with other trades prior to installation.
- 6. All pathways shall include empty space for a minimum of 25% growth beyond initial installation of cabling.
- 7. Cables shall be rigidly supported by cable pathways as indicated on the drawings. Cables shall be physically supported at intervals not to exceed 5 feet (1.52 m).
- 8. Store and keep dry all products in original container in a climate controlled environment until installation is to occur
- 9. Install all pathways:
 - a. So that cables are allowed to be pulled in accordance with referenced standards and guidelines.
 - b. So that cables are allowed to be pulled without damage to conductors, shield, armor, or jacket.

- c. So that cables are not forced or allowed to exceed minimum allowed bend radius by manufacturer or referenced standards and guidelines.
 - d. So that the maximum allowable pulling tension is not exceeded.
 - e. To meet the requirements of the structure and the requirements of all other Work on the Project
 - f. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.
 - g. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Architect.
 - h. Parallel or perpendicular to building lines or column lines.
 - i. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
10. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or other methods shall not be used to attach cables to cable supports.
11. Provide adequate pathways so that cabling is not forced to attach, be supported, or use other pathways not specifically designed and provided for. Any deviation from this will not be accepted.
- a. At no point shall cables come in contact with, be supported by, or attach to other trades equipment or supports.
 - b. At no point shall cables come in contact with, be supported by, or attach to building structures or supports.
12. Provide appropriately sized sleeves where cables (supported by J-hooks) are required to pass through non-rated full-height partitions. Where allowed, sleeves shall extend a minimum of 3 inches beyond the partition surface on both sides, and shall be rigidly supported to support the weight of cables. Sleeves shall be sized so that no more than 40% of the cross-sectional area is utilized by the cabling to be installed.
13. Suspended cables shall be installed with at least 3 inches of clear vertical space above the ceiling tiles and support channels (T-bars).
14. Waterproofing
- a. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.

- b. Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the Owner.

15. Cutting and Patching

- a. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, metalwork, etc. using skilled tradespeople of the trades required at no additional cost to the Owner.
- b. Do not cut, channel, chase or drill masonry, tile, etc., unless permission from the Architect is obtained. If permission is granted, perform this work in a manner acceptable to the Architect.
- c. Patch around all openings to match adjacent construction.
- d. Where conduit or equipment is mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.
- e. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Owner.
- f. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

16. Mounting Heights

- a. Mounting heights for equipment and devices requiring operational access shall conform to ADA requirements.
- b. Wall mounted devices requiring operational access shall be mounted a minimum of 15 inches above finished floor to bottom of device and a maximum of 48 inches above finished floor to top of device.
- c. Mounting heights shall be from floor to center of device, unless otherwise noted. Verify exact locations and mounting heights with the Architect before installation.
- d. Typical mounting heights shall match nearest adjacent typical electrical outlet mounting height UON or as directed by the Architect.

17. Painting

- a. Refer to Division 9 Section "Painting" for painting requirements.
- b. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.

- 1) If painting happens after cabling has been installed, cabling shall be masked off or otherwise protected so that cables are not painted. Paint on cables degrades the cable over time. **PAINTED CABLES SHALL BE REPLACED** with no additional cost to the owner.
 - c. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
 - d. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
 - e. Where factory finishes are provided and no additional field painting is specified, touch-up or refinish, as required by, and to the acceptance of, the Architect and Design Consultant, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Architect or Design Consultant, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.
 - f. Provide touch-up paint as required by Specification Sections in this Division.
18. Fastenings
- a. Fasten equipment to building structure in accordance with the best industry practice.
 - b. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lbs.
 - c. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1) To Wood: Fasten with lag screws or through bolts.
 - 2) To New Concrete: Bolt to concrete inserts.
 - 3) To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4) To Existing Concrete: Expansion anchor fasteners.
 - 5) To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 - 6) To Light Steel: Sheet metal screws.
 - 7) Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

- d. Where weight applied to building attachment points exceeds 300 pounds, coordinate with and obtain the approval of Architect and conform to the following as a minimum:
 - 1) Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
- e. For items, which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.
- f. Areas identified as noise critical spaces shall have all penetrations sealed to minimize sound transmission between adjacent spaces.

B. Access to pathways and associated equipment

- 1. Locate all pull boxes, junction boxes and fire-rated pathway devices so as to provide easy access for operation, service inspection and maintenance.
- 2. Provide an access door/panel where equipment or devices are located above inaccessible ceilings. Where access doors/panels are necessary but not shown on the plans, coordinate type and location with Architect and Design Consultant through an RFI.
- 3. Maintain all code required clearances and clearances required by manufacturers.

C. Cable Distribution

- 1. For low-voltage cabling (that provides power at 70v or less), refer to section 2.1 above.

D. Conduits

- 1. Conduit shall be of the appropriate type required by code and as required by Electrical Division 26.
- 2. Adequate access shall be available where cables enter conduits
- 3. Bond and ground all metallic conduits and boxes in accordance with national or local requirements (ANSI STD-607 – “Commercial Building Grounding (Earthing) and Bonding Requirements For Telecommunications).
- 4. Install conduits in the most direct route possible, running parallel to building lines
- 5. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.
- 6. Conduits which enter Telecommunications or Security/Equipment rooms shall extend 3 inches AFF or through the wall.
- 7. Flexible conduits may only be used where specifically allowed by these contract documents.
 - a. Where indicated, flexible conduit sections shall be less than 20 feet in length.

8. No continuous section of a conduit may exceed 100 feet without a Pull Box.
9. No more than (2) 90° bends, or equivalent will be allowed between Pull Boxes.
 - a. Each and any offset shall be considered a 90° bend.
 - b. A Pull Box is required wherever a reverse bend is installed.
10. The minimum bend radius for conduits is:
 - a. (6) times the inside diameter for 2 inches conduits or less.
 - b. (10) times the inside diameter for conduits greater than 2 inches.
11. Conduits shall contain no electrical condulets (also known as LBs).
12. Underground Conduit Requirements
 - a. Cabling and pathways serving devices exterior to the building, such as emergency phones/towers and security cameras.
 - b. Requirements
 - 1) Refer to applicable details on drawings for illustrative requirements.
 - 2) Route all underground conduit so there is no more than (3) 90 degree bends, including stub-up bend at communications room/equipment cabinet.
 - a) For underground conduit serving outlets/boxes outside the footprint of the building that require more than (3) 90 degree bends, provide appropriately-sized handhole(s). Coordinate location with Architect and Owner, indicate proposed location(s) on shop drawings, and include product information in pre-construction submittals. In general, handholes are NOT to be located in roadways, parking lots, sidewalks, or any location that may be subject to vehicular traffic.
 - b) These underground conduits shall stub directly into the serving Communications Room/Equipment Room. If not, extend cabling within the building in IMC or RMC to the serving Equipment Room.
 - 3) Approved conduit types:
 - a) When routed below slab-on-grade or outside the footprint of the building:
 - i) Horizontal conduit shall be RMC or Schedule 40 PVC a minimum of 12" below grade. If PVC is installed, also install tracer wire.
 - ii) All vertical and horizontal bends and areas subject to vehicular traffic (loads) such as parking lots and roadways shall be RMC or concrete-encased PVC.

E. Outlet boxes

1. No outlet boxes shall be located back-to-back in a wall cavity.
 - a. Where possible offset to next stud cavity, with a minimum of 6 inch separation.
2. Outlet boxes located in fire-rated walls are to have the appropriate firestopping for backboxes. These locations are to be identified on shop drawings.
3. Where cabling enters a backbox directly (not via conduit), provide black rubber grommet on knockout.

F. Pull Boxes

1. Pull Boxes shall be placed in Conveniently Accessible locations.
2. Coordinate the location and installation of all Pull Boxes to ensure adequate access is provided.
3. Pull Boxes above an accessible ceiling shall:
 - a. Be aligned directly over the ceiling grid to allow access
 - b. Be installed with a minimum of 3 inches (76.2 mm) clearance to ceiling grid and tiles
4. No directional changes shall be allowed in Pull Boxes. Conduit shall continue in the same direction as it enters and then change direction via an appropriately sized bend in the conduit.
5. Size Pull Boxes according to the following chart:

TABLE 1: Pull Box Sizing

Conduit	Trade	Size	Width	Length	Depth	Width Increase for Additional Conduit
1"	4"		4"	2-1/8"		N/A
1-1/4"	4"		4"	2-1/8"		N/A
1-1/2"	4"		4"	2-1/8"		N/A
2"	4"		4"	2-1/8"		N/A
2-1/2"	4"		4"	2-1/8"		N/A
3"	4"		4"	2-1/8"		N/A
4"	4"		4"	2-1/8"		N/A

3.2 LABELING

A. Labeling Installation

1. Labels are to be secured by adhesive. They shall have a type of adhesive that is appropriate for the particular surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.

B. Labeling Requirements

1. Labels are to be installed on or for:
 - a. All firestopping systems. For wall and floor penetrations, label on both sides. See Firestopping later in this section.

- b. All pathways (e.g., conduit etc.) installed under this work.
 - 1) Label all conduit with “SECURITY”. Conduit labels shall utilize text readable from a standing position on the finished floor. Conduit sleeves which pass through a single wall or floor need not be labeled.
 - a) For wall stub-up locations, label overhead only.
 - b) For conduits greater than 10', label both ends of conduit with far end location and Room/Number.
 - i) Example – “Security to Panel 1 in Equipment Room 127”.
 - c) For conduits that stub directly up or into an Equipment Room, label both ends of conduit.
 - i) Example: underslab/ground conduit from Equipment Room 127 to Camera #13 attached to an exterior lightpole shall be labeled as follows:
 - (1) Conduit stub-up location in Equipment Room 127 – “Security to Camera #13”.
 - (2) In the lightpole/junction box, immediately adjacent to serving conduit – “Security to Equipment Room 127”.
 - 2) All pullboxes and junction boxes for Security shall be labeled “SECURITY PULLBOX” on the cover, such that the text is of sufficient size to be readable from a standing position on the finished floor.
 - a) Conduits entering and exiting all pullboxes and junction boxes shall be labeled with their destination/room number – ie “To Security Camera #17 in Room 114”.
- c. In general, the label is to be provided and installed by whomever installed the item that is being labeled.
- d. Refer to individual Division 28 sections and to the drawings for additional information on labeling requirements.

3.3 FIRESTOPPING

A. General

- 1. Provide fire resistant materials of a type and composition necessary to restore fire ratings to all wall, floor or ceiling penetrations; including membrane penetrations. All materials shall be classified or listed as a complete system by UL (or an approved NRTL by the Design Consultant and AHJ) and meet NEC and local codes. The use of partial systems or components of systems is not allowed unless specifically identified in the documents.

2. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of smoke, flame, toxic gas or water through the penetration before, during or after a fire. The fire rating (F and T) of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by referenced building codes.
 - a. Assume all floors are fire-rated, unless otherwise noted.
 - b. Also install fire stops at any other locations indicated in the Specifications or Drawings.
 3. Provide a label on both sides of fire rated assembly at all fire stop locations indicating:
 - a. Fire stop Manufacturer
 - b. Installer and company
 - c. Date installed
 - d. UL system number with all relevant ratings indicated
 4. Include labels in each Equipment Room in which one or more fire-rated walls is installed. Provide a 2" block letter stencil label on the inside of the room to indicate rating for each barrier.
 5. Provide systems as identified on the drawings and specified herein. At locations where the cabling routing encounters a fire-rated barrier provide an adequately sized fire stop device for the quantities and types for all cables to be installed plus 25% growth.
- B. Penetration Sealant – Conduits
1. Provide listed system to seal around openings between wall, floor or partition around conduits in accordance with system listing and manufacturer's instructions.
- C. Penetration Sealant – Voids, Cavities, and Openings
1. Install fire stop materials in the framed openings through fire rated partitions per the Architect's drawings and in accordance with the NRTL listed system instructions.
 2. Fire stop all voids, cavities, and openings left by the removal of cabling, conduits, conduit sleeves, cable trays or other equipment related to the communications systems not to be reused.
 3. Install the fire stop system in accordance with the manufacturer's instructions and local codes.
- D. Fire-Rated Pathway Device
1. Provide fire-rated pathway device anywhere cables are required to pass through fire-rated walls, floors or partitions.
 2. Devices shall be installed in locations where required by the Contract Drawings, arranged individually or appropriately ganged.
 3. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.

4. Apply the factory supplied gasketing material (where required) prior to the installation of the wall plates.
5. Secure wall plates (where required) to devices per the equipment manufacturer's recommendations.

END OF SECTION 280501

SECTION 281010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. As part of a complete and functioning Electronic Security System and associated infrastructure, provide conductors and cables of appropriate type. This section includes:
 - 1. Low-voltage Control and Power Cables
 - 2. Coaxial Cabling
- B. Conductor and cable requirements are unique to each manufacturer equipment / device. Unless otherwise noted, exact conductor and cable types are to be coordinated by the ESC to meet the requirements of the Electronic Security manufacturer

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Work under this section shall follow Division 28 Sections “General Electronic Safety and Security Requirements” and “Electronic Security Systems”.
- C. Conductors and cables as specified in this section shall be supported and installed into pathways, backboxes, firestopping, and other general/common work per Division 28 Section “Common Work Results for Electronic Security Systems”.
- D. Refer to Division 27 Specifications for all Category 6 and Fiber Optic Cable requirements.
- E. Refer to Division 28 Section “Equipment Room Fittings for Electronic Security” for grounding and bonding requirements.
- F. Refer to individual Electronic Security System sections for additional conductor and cabling requirements.

1.3 SUBMITTALS

- A. Follow the requirements for submittals in Division 28 Sections “General Electronic Safety and Security Requirements” and “Electronic Security Systems”.
- B. The following additional requirements are due at the following submittal phases:
 - 1. Pre-Construction Submittal
 - a. Cut sheets shall contain the following information for each of the cables specified.

- 1) Manufacturers name and logo
- 2) Cable outside diameter
- 3) Number of conductors/strands in each cable and binder group
- 4) Gauge or strand thickness
- 5) Cable jacket material and rating (ie Plenum, Riser, wet-rated, etc.)
- 6) Maximum pulling tension
- 7) Jacket/Sheath color
- 8) Individual conductor or strand insulation colors (if applicable)
- 9) Minimum bend radius
 - a) During installation and post installation, if it differs.

b. Shop Drawings

- 1) Cable types required by this Section are to be identified on Shop Drawings for the following Electronic Security sub-systems: (separate 281010 Shop Drawings for this section are not needed)
 - a) Access Control
 - b) Video Intercom
 - c) Video Surveillance
- 2) On the Shop Drawings for those Electronic Security sub-systems, show the proposed routing of all conductors and cables and the means of support:
 - a) Cable Tray
 - b) Conduit (solid line)
 - c) J-hooks every 48"-60" (dashed line), if allowed by Contract Documents
- 3) On the Shop Drawings for those Electronic Security sub-systems, include details showing the proposed termination and labeling (ID) scheme at each device and panel for each conductor/cable.

2. Preliminary Project Completion Submittal

- a. Follow all requirements as specified in Division 28 Section "Electronic Security Systems".
- b. Update the approved shop drawings with any changes in cable routing, and submit as part of Preliminary Record Drawings per Division 28 Section "Electronic Security Systems".

- c. Test Results
 - 1) Include conductor/strand test as part of the Functional Test Reports for each Electronic Security sub-system.
- d. Cable ID spreadsheet, saved in PDF and Microsoft Excel file formats, which shall include the following for each cable installed under this section:
 - 1) Electronic Security Sub-System
 - 2) Device Type
 - 3) Device Identifier
 - 4) Device Room Number (if not part of Device Identifier)
 - 5) Headend Panel Identifier
 - 6) Headend Panel Room Number (if not part of Headend Panel Identifier)
 - 7) Cable Identifier

TABLE 1: CABLE IDENTIFICATION SPREADSHEET

<u>Sub-System</u>	<u>Device Type/ID</u>	<u>Device Rm</u>	<u>Headend ID</u>	<u>Headend Rm</u>	<u>Cable ID</u>
Access Control	Card Reader 01	Vestibule 101	ACP-01	IDF 114	AC-CR01-ACP01

- 3. Final Project Completion Submittal
 - a. Follow all requirements as specified in Division 28 Section “Electronic Security Systems”.
 - b. Incorporate any changes from punch list items.
 - c. Include updated Cable ID spreadsheet.

1.4 DEFINITIONS

- A. Damp Location – as defined by the NEC, locations protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture. For the purposes of Work under this division, assume all Damp Locations require wet-rated cabling.
- B. Point of Entrance (Building Entrance) – as defined by the NEC, the point within a building where the security cabling routed through a Wet Location emerges from an external wall, a concrete floor slab, or IMC/RMC.
- C. Qualified Electrician – one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the

hazards involved; in regards to this project, a Qualified Electrician is also licensed in the jurisdiction of the project to install electrical equipment (ie Journeyman or Master Electrician License).

- D. Wet Location - as defined in the NEC, installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL REQUIREMENTS

- A. Conductors and cables shall meet the following the requirements:

1. UL Listed and Approved for the intended application
 - a. Where areas above accessible ceilings are serving as plenum (air) return, and conductors/cabling is not installed in conduit from device to serving panel or Equipment Room, the conductors/cabling shall be Plenum (CMP) rated.
 - b. Where conductors/cabling are installed in conduit from device to serving panel or Equipment Room, the conductors/cabling shall be Riser (CMR) or Plenum rated.
 - c. Where conductors are/cabling are routed through a Wet Location,
2. Cable type and conductor size/quantity shall be as recommended or required by the device/equipment manufacturer. Where the Contract Documents differ from manufacturer recommendations or requirements, notify the Architect requesting clarification.
3. Conductor sizes, if shown, are minimum. Where approved by the Design Consultant and at no extra cost to the Owner, larger conductor sizes may be installed at Contractor's option in order to utilize stock sizes, provided raceway sizes are increased to correspond with fill ratio requirements defined the NEC.
4. Conductors and cables shall be shielded.
 - a. Submit RFI for any manufacturer equipment that recommends non-shielded cable.

- B. The following Manufacturers are conditionally approved:

1. Belden
2. Draka
3. General Cable
4. Tappan
5. West Penn Wire

2.2 LOW-VOLTAGE CONTROL AND POWER CABLES

- A. For 10 AWG through 24 AWG, and single conductors through 24-pair applications, as needed per project.
- B. General requirements:
 - 1. Shielded (overall shield)
 - 2. Stranded and insulated conductors
 - 3. PVC jacket
 - 4. Size conductors per manufacturer recommendations and power/voltage drop based on installed cable length.
- C. Manufacturer shall be:
 - 1. Submit product cutsheets concurrently with Shop Drawings, identifying cable type, manufacturer, and part number on the Riser Diagram.
 - a. Call out non-plenum (Riser-rated and Wet-rated) cables (where specifically allowed)

PART 3 - EXECUTION

3.1 CABLE INSTALLATION

- A. Pre-Installation
 - 1. Following the Notice to Proceed, the ESC's Quality Control Specialist or Project Manager (as defined in Division 28 section "Electronic Security Systems") shall coordinate with the Contractor or Sub-Contractor responsible for Division 28 "Common Work Results for Electronic Security Systems" (ie the conduits, backboxes, etc), if Contractors are different. Items of coordination shall include, but are not limited to:
 - a. Conduit routing
 - b. Conduit type for Building Entrance(s) – (see requirements below)
 - 2. Conduit routing and type shall be indicated on at least one of the following Pre-Construction Shop Drawings:
 - a. Division 28 "Common Work Results for Electronic Security"
 - b. Division 28 "Electronic Security Systems"
 - 3. After conduits/pathways are installed, but prior to cable installation, ESC's Quality Control Specialist and Project Manager shall inspect the Common Work (pathways and backboxes), paying special attention to:

- a. Conduit sizes and quantities matches Construction Documents and Project requirements
- b. Minimum bend radius
- c. Quantity of bends in conduit between pullboxes (180 degree change in direction, maximum)
- d. Building Entrance conduits are of appropriate type
- e. Any visible indication of improper or incomplete installation that may damage cable as it is installed.

B. General Requirements

- 1. Unless otherwise noted, all cables shall be routed through concealed conduit raceway.
 - a. Conduits are not required above accessible (drop) ceilings; when not installed in conduit, cables shall be supported via j-hooks every 48 to 60 inches or less and at every change in direction. For areas where accessible ceiling is not available for pathway back to the Equipment Room, cables may be consolidated and routed in overhead conduit and conduit sleeves.
 - b. Contractor is responsible for determining final cable and conduit routing; conduits may be consolidated in overhead pullboxes in accordance with Division 28 Section "Common Work Results for Electronic Security"; proposed (cable and) conduit routing and sizing shall be indicated on pre-construction shop drawings.
- 2. Install continuous conductors between outlets, devices and boxes without splices or taps. Do not pull connections into raceways. Leave at least 12 inches of conductor in backbox at each device location.
- 3. A Qualified Electrician shall install all control wire operating at 120V nominal and above. Control wiring operating at less than 120V (e.g., 12V and 24V) may be installed under the Division furnishing it.
- 4. All cables shall be plenum-rated unless noted otherwise.
- 5. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.
 - a. Except when supported by ladder racking within each Telecommunications room, UON.
- 6. At the same time horizontal cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. 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 cord.
- 7. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable
- 8. Comply with all referenced standards and guidelines.

9. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.
10. Where space allows, all cables shall be provided with slack/service loops near each end of the cable, one in the accessible ceiling space or overhead J-box at the device and one at the Equipment Room. Each slack/service loop shall be:
 11. A minimum of 3 feet (1 meter) in length, unless noted otherwise.
 12. Prior to using any cable pulling lubricants provide the Design Consultant with written documentation from the cable manufacturer supporting the cable manufacturers' acceptance of its use in compliance with all required warranties as part of these contract documents. The use of non-water based lubricants shall be provided when pulling PVC jacketed and all cables not suitable for contact with water.
 13. Install all cables and conductors in compliance with the requirements of Article 725 of the NEC, paying special attention to the following:
 - a. Cables shall be installed in a neat and workmanlike manner.
 - b. Separation requirements dependent upon installation location and proximity to other circuits.
- C. Outside plant (OSP)/wet-rated cable installation: for cables placed in Wet Locations or as required by these construction documents. (I.e. all cables which extend beyond the footprint/envelope of the building or pathways leading to floor-boxes embedded in a ground floor slab)
 1. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling space nor shall they be allowed to transition between different levels of the building.
 2. Rigid or intermediate metallic conduit shall be used to route outdoor (unlisted) cabling to the serving Equipment Room in accordance with the NEC; or a suitably-sized junction box shall be provided in an accessible location within 50' of where the outdoor cabling/conduit enters the building enters the building to allow the cable to transition from wet-rated to plenum-rated.
 - a. Indicate this location on pre-construction shop drawings and final Record Drawings.
 3. All cables which extend beyond the envelope/footprint of the building shall be installed with entrance protectors in accordance with Division 28 Section "Equipment Room Fittings for Electronic Security".

3.2 CABLE IDENTIFICATION

- A. Label all cabling with machine-printed labels according to the labeling scheme identified on the drawings or as described in Division 28 Section "Electronic Security Systems". Where the drawings and specifications are silent, submit RFI through appropriate channels requesting labeling scheme.
 1. Shop drawings shall include floor plan and/or riser diagram that indicates proposed cable/device identification for each device.

- B. Cables shall be labeled within 6" at each end.
- C. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:
 - 1. Brady, IDXPRT
 - 2. Hellermann Tyton, Spirit 2100
 - 3. Panduit LS9
 - 4. Or equivalent

3.3 GENERAL CABLE TESTING

- A. Pre-installation testing:
 - 1. Visually inspect all cables, cable reels/boxes, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
 - 2. Do not install any cable with less than the manufacturer's guaranteed number of serviceable conductors.
- B. Post-installation testing (but prior to termination to devices/panels):
 - 1. Conduct cable continuity testing upon completion of installation on each conductor.
 - 2. Remove all defective cables from pathway systems. Do not abandon cables in place.

3.4 CABLE TERMINATIONS

- A. Cable connections to device and security panel shall be soldered and heat-shrunk from jacket to jacket. Exposed conductors, even within an enclosure or backbox, are not allowed.

3.5 ACCEPTANCE

- A. The ESC's Quality Control Specialist shall conduct an inspection after conductors and cabling have been installed to ensure compliance with the Construction Documents and project requirements.
- B. Functional tests of the conductors and cables connected to equipment will be conducted by the ESC as part of Test Reports as specified in Division 28 "Electronic Security Systems" and individual Electronic Security sub-system Sections.

END OF SECTION 281010

SECTION 284600 - FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Penetration Firestopping" for material and methods for firestopping systems.
 - 2. Division 26 Section "Common Work Results for Electrical," for materials and methods for coordination, sleeves and common installation requirements.

1.2 DESCRIPTION OF WORK

- A. This Section requires the Contractor to furnish all materials required to install the fire alarm system. The Contractor shall be responsible for installing, testing, and start-up of a complete functioning fire alarm system, and each element thereof, as specified or indicated on the Drawings or reasonably inferred, including every article, device or accessory (whether or not specifically called for by item) necessary to facilitate each system's function as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation and utilities.
- B. Division 28 of the Specifications and Drawings numbered with prefixes FP generally describe these systems, but the scope of the Fire Alarm work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Fire Suppression, Mechanical, Plumbing, Fire Alarm and Electrical Drawings and Specifications; and Addenda.
- C. The Drawings have been prepared diagrammatically and are intended to convey the scope of work, indicating the general location and arrangement of the major equipment, devices, appliances, etc. without showing all the exact details as to elevations, circuits, routing, and other installation requirements. Use the Drawings as a guide when laying out the system and verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. The scope of work in this section includes:
 - 1. Fire alarm control unit
 - 2. Remote annunciator

3. Manual fire alarm pull stations
4. System smoke detectors
5. Heat detectors
6. Carbon monoxide detectors
7. Notification appliances
8. Sprinkler system waterflow and valve tamper alarms
9. Magnetic door holders
10. Elevator recall
11. Air handling unit shutdown
12. Battery stand-by power
13. Digital alarm communicator transmitter (DACT)

1.3 QUALITY ASSURANCE

- A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.
- B. All work shall be installed in strict conformance with manufacturer's requirements and recommendations. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.
- C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.
- D. Installation of devices shall be performed or supervised by a National Institute for Certification of Engineering Technologies (NICET) Level 2 or higher Fire Alarm Technician. Submit copies of the certification for employees through shop drawing submittals.

1.4 APPLICABLE CODES AND STANDARDS

- A. Execute Work in accordance with the National Fire Protection Association Standards and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities. Upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

- B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.
- C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.
- D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes.
 - 1. NFPA 70, “National Electrical Code”, 2017 Edition. NFPA 72, “National Fire Alarm and Signaling Code”, 2016 Edition.
 - 3. Underwriters Laboratories, “Fire Protection Equipment Directory”, Latest Edition.
 - 4. International Building Code (IBC) 2018 Edition with local amendments.
 - 5. International Fire Code (IFC) 2018 Edition with local amendments.
 - 6. ASME A17.1, “Safety Code for Elevators and Escalators”, Current Edition.
- E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

1.5 DEFINITIONS

- A. General:
 - 1. Furnish: The term “furnish” is used to mean “supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations.”
 - 2. Install: The term “install” is used to describe operations at the project site including the actual “unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.”
 - 3. Provide: The term “provide” means “to furnish and install, complete and ready for the intended use.”
 - 4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.
 - 5. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the AHJ over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.

- 6. FACP: Fire Alarm Control Panel.
 - 7. NICET: National Institute for Certification in Engineering Technologies.
 - 8. VESDA: Very Early Smoke-Detection Apparatus.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

1.6 COORDINATION

- A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.
- B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping in the manner anticipated in the design.
- C. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the Fire Alarm systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the work in such a manner that the work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.
- D. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.
- E. Where coordination and interfacing with other systems or equipment is required, it shall be the responsibility of the fire alarm system installer (contractor) to either provide the relays, contacts, power supplies and other necessary hardware or see to it that such hardware is provided with the other systems or equipment.
- F. The contractor shall coordinate work in this section with all related trades. Work and/or equipment provided in other sections and related to the fire alarm system shall include, but not be limited to:
 - 1. Sprinkler waterflow and valve tamper switches shall be provided by the fire sprinkler installer, but wired and connected by the fire alarm installer.

2. Duct smoke detectors shall be furnished, wired and connected by the fire alarm system installer. The HVAC installer shall furnish necessary duct opening to install the duct smoke detector's housing.
 3. Air handling fan control circuits and contacts to be furnished by the HVAC control equipment.
 4. Conduit shall be by Division 26 "Common Work Results for Electrical".
- G. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.7 MEASUREMENTS AND LAYOUTS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.8 SUBMITTALS

- A. Refer to Division 1 and General Conditions for submittal requirements, in addition to requirements specified herein. Submittals not complying fully with the submittal requirements will be rejected.
- B. Contractor shall prepare installation drawings (working shop drawings) based upon this design. Requests for deviations from the approved design shall be submitted in writing to the Engineer of Record for approval.
- C. Shop drawings shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code and relevant laws, ordinances, rules and regulations. Drawings that are not legible, or that do not contain sufficient detail to verify compliance with applicable codes and standards, will be rejected without further review.
- D. Submittals and shop drawings shall not contain HEI's firm name or logo, nor shall it contain the HEI's engineers' seal and signature. They shall not be copies of HEI's work product. If the contractor desires to use elements of such product, the license agreement for transfer of information at the end of this section must be used.
- E. Submit Shop Drawings as early as required to support the project schedule. Allow for two weeks Engineer review time plus mailing time plus a duplication of this time for resubmittal if required. Submit Shop Drawings as soon as possible before construction starts.
- F. Before submitting Shop Drawings and material lists, the Contractor shall verify that the equipment submitted is mutually compatible and suitable for the intended use. Contractor shall

verify that the equipment will fit the available space and allow ample room for maintenance. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

- G. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the shop drawings have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the electronic submittal and shall clearly indicate the materials, performance criteria and accessories being proposed. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- H. The Engineer's checking and subsequent acceptance of such submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless he has, in writing, called the Engineer's and Architect's attention to such deviations at the time of submission, and secured written acceptance; nor shall it relieve him from responsibility for errors in dimensions, details, sizes of members, or quantities; or for omissions of components or fittings; or for not coordinating items with actual building conditions and adjacent work.
- I. Product Data: Provide a bill of materials and product cutsheets showing material specifications, electrical characteristics and connection requirements. Highlight or indicate specific product options and accessories as applicable to the project.
- J. Shop Drawings:
 - 1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - 2. Shop drawings shall be prepared by a NICET Level II or higher certified technician. Submit copies of the certification for the designer with submittal.
 - 3. The fire alarm system equipment vendor shall provide shop drawings showing fire alarm floor plans and a full building riser diagram. Fire alarm floor plans and riser diagram shall show fire alarm control panel, annunciator, all fire alarm initiating devices and notification appliances. Show typical wiring diagrams of control panel/s, annunciator and each device and wiring connections required. Show all interfaces to other systems, such as temperature control systems, and security systems.
 - 4. The fire alarm floor plans and riser diagram shall show wiring to all fire alarm devices/appliances, indicating wire sizes and quantities as well as conduit/raceway sizes and locations of end-of-line (EOL) resistors. The fire alarm floor plans and riser diagram shall clearly show the routing of all fire alarm system wiring, including all horizontal routing and vertical routing (in chases).
 - 5. Routing of all fire alarm wiring shall comply with the "Survivability" requirements of NFPA 72.

6. Provide a Sequence of Operations Matrix that explains how the submitted fire alarm system functions.
 7. Include voltage drop calculations for notification-appliance circuits.
 8. Include battery-size calculations.
 9. Shop drawing scale shall match the Engineer's drawings where possible. Scale shall not be less than $3/32" = 1'-0"$.
 10. Shop drawings shall be produced using computer-aided design. Hand drawn documents will not be reviewed or approved.
- K. Indicate within the submittal all applicable UL listings and all applicable approvals or certifications.
- L. Qualification Data: Submit copies of the certification for the Installer.
- M. 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 products.

1.9 ELECTRONIC DRAWING FILES

- A. In preparation of shop or record drawings, Contractor may, at his option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall complete and send the form attached at the end of this section along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

- A. Refer to Division 1 and General Conditions for Substitutions.
- B. Materials, products and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten calendar days prior to the date for receipt of Bids. Each such request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawings, cuts, performance and test data and other information necessary for an evaluation. A statement setting forth changes in other materials, equipment or other Work that incorporation of the substitute would require shall be included. The burden of proof of the merit of the proposed substitute is upon the proposer. The Engineer's decision of approval or disapproval to bid of a proposed substitution shall be final.

- D. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
- E. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE DATA

- A. Refer to Division 1 and General Conditions for Operational and Maintenance Manuals.
- B. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- C. The O&M Manuals shall be provided in labeled 3-ring binder with cover, binding label, tabbed fly sheets and plastic insert folders for Record Drawings. Include the following sections with the appropriate information for each section:
 - 1. Typewritten Index.
 - 2. Qualifications. Provide designer and installer qualification.
 - 3. Bill of Materials. Provide complete nomenclature, model number and vendor information for all parts.
 - 4. Operating Instructions. Complete instructions detailing operation and maintenance of all equipment installed.
 - 5. Product Data: Provide product cutsheets for all equipment utilized and installed.
 - 6. Riser diagram.
 - 7. Device addresses.
 - 8. Record copy of site-specific software.
 - 9. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - a. Equipment tested.
 - b. Frequency of testing of installed components.
 - c. Frequency of inspection of installed components.
 - d. Requirements and recommendations related to results of maintenance.
 - e. Manufacturer's user training manuals.

10. Manufacturer's required maintenance related to system warranty requirements.
11. Abbreviated operating instructions for mounting at fire alarm control unit and each annunciator unit.
12. Guarantee. Copy of all guarantees and warranties issued.
13. Contact list with minimum three service representative phone numbers.

1.12 RECORD DRAWINGS

- A. A set of prints shall be kept on the jobsite during construction for the purpose of noting changes to location of all fire alarm equipment, devices, appliances and circuits as finally installed. During the course of construction, the Contractor shall indicate on these drawings, changes made from the Contract Drawings. Particular attention shall be made to those items which need to be located for servicing.
- B. The record drawings shall show actual locations of initiating devices, notification appliances, and end-of-line devices. Show the approximate location, size and type of all wiring and routing of wiring. Drawings should also include one-line riser diagrams showing all devices.
- C. The Contractor shall sign-off on the Record Drawings as being an accurate representation of the completed installation.
- D. Refer to Division 1 and General Conditions for Record Drawings
- E. At the completion of the project, the Contractor shall obtain at his expense, reproducible copies of the drawings and incorporate changes noted on the jobsite work prints onto these sheets. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", with date. The drawings and associated system calculations shall be delivered to the Architect/Engineer.

1.13 SPARE PARTS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Provide 10% of the total or a minimum of one (1) manual pull station.
 2. Provide 10% of the total or a minimum of two (2) of each type of automatic smoke detector.
 3. Provide 5% of the total or a minimum of one (1) of each type of automatic heat detector.
 4. Provide 5% of the total or a minimum of two (2) of each strobe type and candela rating.
 5. Provide 5% of the total or a minimum of two (2) of each speaker type. Combination horn/speaker/strobe units matching the units installed are acceptable.
 6. Keys and Tools: One extra set for access to locked or tamper proofed components.

1.14 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products indicated in this section with minimum three years documented experience.
- B. Installer: Company specializing in installing the products indicated in this section with minimum three years documented experience. Shall be bondable and licensed Contractor and employ full-time factory-trained and certified installers and technicians. Installers shall provide with the fire alarm submittal proof of factory training for each installer.
- C. Final checkout and verification: Shall be conducted by a technician certified by the National Institute for Certification in Engineering Technologies (NICET) registered as level 2 or higher in the fire protection technology certification program. Provide certification information with fire alarm submittal.
- D. The equipment manufacturer's service department shall be fully stocked in standard parts and components and engaged in the maintenance of fire alarm systems. On-the-premises service shall be available within 4 hours of notification, 7 days a week, 24 hours a day.

1.15 GUARANTEES AND WARRANTIES

- A. Refer to Division 1 and General Conditions for Guarantees and Warranties.
- B. Furnish service and maintenance of fire alarm system including wiring and raceways for one year from date of substantial completion.
- C. All components, system software, parts and assemblies shall be guaranteed against defects in materials and workmanship for the one-year period stated above, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty.
- D. Labor (including travel expenses) to trouble-shoot, repair, reprogram, or replace components shall be furnished by this contractor at no charge during the warranty period.
- E. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software.

1.16 PROJECT CONDITIONS

- A. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

PART 2 - PRODUCTS AND MATERIALS

2.1 SYSTEM DESCRIPTION

- A. Noncoded, UL-listed addressable system, with multiplexed signal transmission and voice/strobe evacuation.

- B. All components provided shall be listed for use with the selected system.
- C. 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.
- D. Source Limitations for Fire alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested, and will operate, as a system.

2.2 MANUFACTURER

- A. Subject to compliance with requirements, provide products manufactured by the following manufacturers as indicated on the Drawings:

- 1. Notifier

2.3 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire alarm signal initiation shall be by one or more of the following devices and systems:

- 1. Manual pull stations.
- 2. Heat detectors.
- 3. Smoke detectors.
- 4. Carbon monoxide detectors.
- 5. Automatic sprinkler system water flow.
- 6. Fire extinguishing system operation.

- B. Fire alarm signal shall initiate the following actions:

- 1. Identify alarm and specific initiating device at fire alarm control unit and remote annunciators (if provided).
 - a. A pulsing alarm tone shall occur within the control panel until acknowledged.
 - b. The alarm LED shall flash on the control panel and remote annunciator panel until the alarm has been acknowledged at the control panel/remote annunciator panel. Once acknowledged, this same LED shall latch on and the custom label for the address in alarm shall be displayed on the alphanumeric LCD readout. A subsequent alarm received from another address after acknowledged shall flash the alarm LED on the control panel showing the new alarm information.
- 2. Transmit an alarm signal to the alarm supervising station.

3. Audible notification appliances shall sound until silenced by the alarm silence switch at the control panel.
 4. All visible alarm notification appliances shall display a continuous synchronized pattern until reset by the Alarm Reset Switch.
 5. Record events in the system memory.
 6. Unlock electric door locks in designated egress paths.
 7. Release fire and smoke doors held open by magnetic door holders.
 8. Activate voice/alarm communication system.
 9. All fan-powered air-handling equipment shall shutdown and remain down until the fire alarm control panel is reset.
 10. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 11. Activate emergency lighting control.
 12. Shutdown audio system.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
 2. Duct-smoke detectors
 - 3.
 4. Independent fire detection and suppression systems.
 5. User disabling of zones or individual devices.
 6. Loss of communication with any panel on the network.
- D. System Supervisory Signal Actions:
1. Identify specific device causing supervisory signal fire alarm control unit and remote annunciators (if provided).
 - a. Visible and audible supervisory alarm indicated by address at fire alarm control panel.
 - b. Manual acknowledge function at fire alarm control panel and remote annunciator panel silences audible supervisory alarm; visible alarm is displayed until device is returned to its normal position/supervisory condition is cleared.
 2. Record events in the system memory.

3. After a time delay of 90 seconds transmit a supervisory signal to the alarm supervising station.
 4. Duct-mounted smoke detectors shall shutdown their respective unit upon detection of smoke and remain down until manually reset.
 5. Individual fan-powered air distribution equipment less than 2,000 cfm that is not provided with duct detection shall shutdown when the respective air handling unit is shutdown.
- E. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 4. Loss of primary power at fire alarm control unit.
 5. Ground or a single break in internal circuits of fire alarm control unit.
 6. Abnormal ac voltage at fire alarm control unit.
 7. Break in standby battery circuitry.
 8. Failure of battery charging.
 9. Abnormal position of any switch at fire alarm control unit or annunciator.
 10. Voice signal amplifier failure.
- F. System Trouble Signal Actions:
1. Identify specific device causing trouble signal fire alarm control unit and remote annunciators (if provided).
 - a. Visible and audible trouble alarm indicated by address at fire alarm control panel.
 - b. Manual acknowledge function at fire alarm control panel and remote annunciator panel silences audible trouble alarm; visible alarm is displayed until device is returned to its normal position/trouble condition is cleared.
 2. Record events in the system memory.
 3. After a time delay of 90 seconds, transmit a trouble signal to the alarm supervising station.

2.4 FIRE ALARM SYSTEM CONTROL UNIT

A. General Requirements for Fire alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
 - a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 - c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
 - d. The FACP shall be listed for connection to a central-station signaling system service.
 - e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
 - f. The control unit shall have dedicated alarm, supervisory and trouble LED's and dedicated alarm, supervisory and trouble acknowledge, and alarm silence switches.
 - g. Lamp Test: Manual lamp test function causes each LED to function at fire alarm control panel.
 - h. Drill Sequence of Operation: Manual drill function causes alarm mode operation as described above.
 - i. The FACP shall be provided with surge protection.
 - 1) Install in a surface mounted enclosure.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands. and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits: Provide circuitry, which meets the performance requirements during abnormal conditions, based upon the class of the circuitry selected.

1. Initiating Device Circuits: Class B .
 - a. Pathway Survivability: Level 0.
 2. Notification Appliance Circuits: Class B .
 - b. Pathway Survivability: Level 0.
 3. Signaling Line Circuits: Class B .
 - c. Pathway Survivability: Level 0.
 4. Any circuits interconnecting fire alarm control panels between separate buildings shall be provided with surge protection.
- D. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals and digital alarm communicator transmitters shall be powered by 24-V dc source.
1. The location of the dedicated branch circuit disconnecting means shall be permanently identified at the control unit.
 2. The circuit disconnecting means shall have a red marking and be provided with a breaker lock or other approved method to avoid accidental operation.
 3. Alarm current draw of entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
- E. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
1. Batteries: Sealed lead acid.
 2. The secondary power system shall operate system in standby mode for 24 hours followed by alarm mode for 15 minutes.
- F. System Supervision: Automatically detects and reports open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification appliance circuits. Alarm, supervisory and trouble signals shall be monitored by the supervising station over a Digital Alarm Communicator Transmitter (DACT), or other approved method.
- G. Elevator Recall and Shutdown: Provide output signals to the elevator controller(s) using addressable relays to initiate elevator recall and shutdown functions per ASME A17.1. Provide equipment, output signals and logic as required by code and by the elevator system supplier and installer.
1. Elevator recall shall be initiated by any one of the following alarm-initiating devices:
 - a. Elevator lobby detector(s).
 - b. Smoke detector in elevator machine room.

- c. Heat detector(s) in elevator pit.
- 2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
- 3. Elevator shutdown shall be initiated by any one of the following alarm-initiating devices:
 - a. Heat detector in elevator machine room.
 - b. Heat detector(s) at top of elevator hoistway.

2.5 EMERGENCY VOICE/ALARM COMMUNICATIONS SYSTEMS (EVACS):

- A. The system shall incorporate one-way emergency voice communication via specified speakers. A central audible module shall provide for the necessary alarm message/tone generation, main and remote microphone connections and mixers/pre-amplifier circuits. Continuous supervision shall be provided along with specific information as to the type of failure (main microphone trouble, tone trouble, etc.)
 - 1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.
 - a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
 - b. Programmable tone and message sequence selection.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear."
 - d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire alarm control unit.
 - 2. Hand held push to talk, noise canceling microphone in recessed protective panel mounted enclosure; 5 feet coiled cable; and LED to indicate the microphone push to talk has been pressed.
 - 3. Audible power amplifiers shall be self filtered; contain 24 volt power supply, transformer and amplifier monitor circuits; Amplifier shall operate all system speakers plus twenty-five (25) percent spare capacity.
 - 4. Digitized voice messages are required to notify building occupants during alarm conditions. Message player shall not rely on tape or mechanical means of transmitting the voice message. A standard evacuation message shall be provided; however, the system shall be capable of transmitting a custom message of up to five (5) minutes long.
 - 5. Alarm sequence shall consist of a temporal (3) alarm tone for a maximum of 15 seconds followed by an automatic pre-selected message. At the end of the message the tone shall

resume. This sequence shall continue until the fire alarm control panel has been silenced. Manual voice paging shall be available via panel switches to page individual floors or groups of floors. Each floor shall be an individual audible zone and have a corresponding audible switch.

2.6 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter (DACT) shall be acceptable to the central station and shall comply with UL 864.
- B. The installing contractor shall select the appropriate DACT equipment based on the available communication methods.
- C. Coordinate with General Contractor to ensure proper connections are provided for communication to and from the DACT. Two (2) separate communication methods are required and shall not be subject to a common failure within the scope of work identified within these contract documents. Unless noted otherwise, the installing contractor shall utilize two (2) of the following communication methods:
 - 1. Copper wire (POTS) telephone line for fire alarm use as required by NFPA 72.
 - a. If two (2) POTS telephone lines are utilized per NFPA 72, additional communication methods are not required.
 - 2. Building 10/100 Base network (LAN), DSL modem, or cable modem.
 - 3. GSM cellular networks in the area including 2G, 3G and 4G.
 - a. The transmitter shall automatically detect and choose the best network in the area based on signal strength and immediately self-adjust for operation as necessary.
 - 4. Other alternative method complying with the performance requirements of NFPA 72 for 'Communication Methods for Supervising Station Alarm Systems that is acceptable to the Authority Having Jurisdiction and the Engineer of Record. Approval of any alternative methods must be obtained from the Engineer of Record via an RFI prior to submitting bids for the scope of work.
- D. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire alarm control unit and automatically transmit across the primary communication method. If service on the primary communication method is interrupted for longer than 45 seconds, the transmitter shall initiate a local trouble signal and transmit a signal indicating loss of primary communication to the supervising station over the secondary communication method. Transmitter shall automatically report communication restoration to the supervising station. If service is lost on both communication methods, transmitter shall initiate a local trouble signal.
- E. Digital data transmission shall include the following:
 - 1. Address of the alarm initiating device.
 - 2. Address of the supervisory signal.

3. Address of the trouble signal.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.
8. Communication bus failure.

- F. Secondary Power: Integral rechargeable battery and automatic charger.
- G. Self-Test: Conducted automatically every 24 hours with report transmitted to supervising station.

2.7 REMOTE ANNUNCIATOR

- A. Existing remote annunciator to remain. If replaced, refer to following information:
1. Description: Alphanumeric display and LED indicating lights shall match those of fire alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.
 - a. Mounting: Surface.
 - b. Provide remote microphone and emergency/voice alarm system controls.

2.8 INITIATING DEVICES

- A. Manual Fire Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Double action mechanism requiring two actions to initiate an alarm, pull lever type; with integral addressable module arranged to communicate manual station status (normal, alarm, or trouble) to fire alarm control unit.
 2. Station Reset: Key or wrench operated switch.
 3. Indoor Protective Shield: Factory fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
- B. System Smoke Detectors: Photoelectric type complying with UL 268 operating at 24-V dc, nominal with integral addressable module arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control unit.

1. Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base.
 2. Device shall have an integral visual-indicating light, LED type, indicating detector has operated and power-on status.
 3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 4. Photoelectric detectors shall have sensitivity between 0.5 and 3.5 percent/foot smoke obscuration.
- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A with a standard, relay or isolator detector mounting base. Provide manufacturer's standard housing to protect the measuring chamber from damage and insects. Provide drilling templates and gaskets to facilitate locating and mounting the housing.
1. Provide for variations in duct air velocity between 100 and 4,000 feet per minute.
 2. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied. Provide an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet.
 3. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 4. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor control circuit.
 5. Provide remote alarm LEDs and remote test stations as shown on the plans.
 6. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
- D. Carbon Monoxide Detectors: Detector complying with UL 2075 and listed for connection to fire alarm system. Detector shall include alarm contacts and trouble contacts. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults. Locate, mount, and wire according to manufacturer's written instructions. Testable by introducing test carbon monoxide into the sensing cell. Test button simulates an alarm condition.
- E. Heat Detectors – Comply with UL 521. Detector shall have twist lock base interchangeable with smoke detectors bases and be equipped with an integral addressable module arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control unit.
1. Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.

2.9 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 - 1. Combination Devices: Factory integrated audible and visible devices in a single mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections. Minimum audible level and strobe intensity shall meet all requirements for separate appliances.
 - 2. Provide strobe synchronization as required per NFPA 72.
 - 3. Wall mounted notification appliances shall be manufacturer standard white finish.
 - 4. Ceiling mounted notification appliances shall be manufacturer standard white finish.
- B. Alarm Speakers: Comply with UL 1480. High quality tone and voice reproduction; capacitor connected for connection to supervised notification appliance circuit; semi-flush mounting; four inch cone; high impact, flame retardant PC/ABS thermoplastic; 25 or 70 VRMS; multi-tapped output power rated $\frac{1}{4}$ to 2 watts and produce 79 to 88 dB at 10 feet.
- C. Visible Alarm Notification Appliances (Strobes): Xenon strobe lights complying with UL 1971, unfiltered or clear filtered white light, with candela ratings as indicated on drawings. Strobes shall meet all requirements of the Americans with Disabilities Act.

2.10 AUXILIARY DEVICES

- A. Magnetic Door Holders: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
 - 1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
 - 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 - 3. Rating: 120-V ac.
- B. Waterflow Alarm Switches: Shall be provided by the Fire Sprinkler Installer and shall be wired complete and ready for use by the Fire Alarm System Installer. Switch shall have an adjustable delay to minimize false alarms due to fluctuations in water pressure.
- C. Valve (Tamper) Switches: Shall be provided by the Fire Sprinkler Installer and shall be wired complete and ready for use by the Fire Alarm System Installer.
- D. Monitor Module: Addressable microelectronic module providing a system address for alarm initiating devices for wired applications with normally open contacts. Include address setting means on the module.
- E. Control/Relay Module: Provide intelligent control relay modules. The Control Relay Module shall provide one form "C" dry relay contact rated at 2 amps @ 24 VDC to control external

appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware.

- F. Fire Department Key Box: Shall be by Knox Company or as otherwise specified by the authority having jurisdiction. Provide internal switch(es), as required by the Authority Having Jurisdiction, to indicate supervisory condition(s) at the fire alarm control and annunciator panels.

2.11 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for smoke detectors, notification appliances, or other device requiring protection as indicated on the plans.
 - 1. Factory fabricated and furnished by device manufacturer.
 - 2. Finish: Factory finished to match the color of the protected appliance or device.

2.12 FIRE ALARM WIRE AND CABLE

- A. Fire Alarm Power Branch Circuits: Building wire as specified in Division 26.
- B. Fire alarm Wire and Cable: NRTL listed and labeled as complying with NFPA 70 (NEC) Article 760. All wiring, including wiring to existing modified devices and appliances shall be new.
- C. Signaling Line, Initiating Device and Notification Appliance Circuits: Power limited fire protective signaling cable, solid copper conductor, 300 volts insulation, suitable for temperature, conditions and location installed. Minimum wire size for initiating device circuits, control circuits and notification appliance circuits shall be determined by calculations and manufacturer's requirements or recommendations. Wire and cable shall be twisted and shielded if recommended by the system manufacturer.
- D. The type of cable chosen should be based on fire alarm system requirements, specification requirements and applicable code requirements. Consideration should also be given to the length of cable runs and potential interference.
- E. Initiating, notification, and control circuits shall be sized based on 20% additional power consuming devices.
- F. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."
- G. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
- H. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket and red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated.

2.13 ACCESS TO EQUIPMENT

- A. All detectors, modules, equipment, etc. shall be located so as to provide easy access for operation, service inspection and maintenance.
- B. Access Doors:
 - 1. Provide access doors for all concealed equipment, except where above lay-in ceilings.
 - 2. Access doors shall be adequately sized for the devices served with a minimum size of 18" x 18", furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
 - 3. Access doors must be of the proper materials for type of construction where installed.
 - 4. The exact location of all access doors shall be verified with the Architect prior to installation.
 - 5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
 - 6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
 - b. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - 7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
 - 8. Locking Devices: Flush, screwdriver-operated cam locks.
 - 9. 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. Arrow United Industries.
 - b. Bar-Co., Inc.
 - c. J.L Industries.
 - d. Karp Associates, Inc.
 - e. Milcor Div. Inryco, Inc.

- f. Nystrom Building Products
- g. Wade
- h. Zurn

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall install, program and test all new equipment identified in this contract and revise existing equipment as noted in accordance with the applicable codes, standards, and manufacturer's instructions.
- B. The installation supervisor shall be on the job site during the entire installation. The installation supervisor shall maintain marked up copies of the drawings at the job site showing as-built conditions. These drawings shall be updated daily and available for Owner review.
- C. The Contractor shall provide all required conduit and all associated hardware, and shall install (pull), connect, and test all cable for a complete fire alarm system. All wiring shall be installed in accordance with the guidelines of these specifications and documents as well as the NFPA codes and standards listed in these specifications.

3.2 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 and requirements of authorities having jurisdiction for installation and testing of fire alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

- B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.
- C. Manual Fire alarm Boxes: Provide manual fire alarm boxes as shown on drawings. Mount manual fire alarm box on a background of a contrasting color. The operable part of manual fire alarm box shall be at 48 inches above floor level unless noted otherwise.
- D. Smoke and Heat Detectors: Provide detectors as shown on drawings.
 - 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke detector spacing.
 - 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat detector spacing.
 - 3. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
 - 4. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
 - 5. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
 - 6. Install ceiling mounted detectors in areas with exposed structure tight to underside of floor/roof deck unless noted otherwise on drawings.
- E. Duct Smoke Detectors: Comply with NFPA 72. Install sampling tubes so they extend the full width of the duct. Tubes more than 36 inches long shall be supported at both ends.
 - 1. Do not install smoke detector in duct smoke detector housing during construction. Install detector only during system testing and prior to system turnover.
 - 2. Provide duct detection and shutdown for fan powered air distribution equipment exceeding 2,000 cfm.
 - 3. Provide equipment and connections to shutdown fan powered air distribution equipment with a capacity less than 2,000 cfm that are part of an air distribution system with a capacity greater than 2,000 cfm.
- F. Carbon Monoxide Detections: Provide detectors as shown on drawings. The installation shall comply with manufacturer's recommendations and NFPA 720, "Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment," as referenced by NFPA 72.
- G. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in unsprinklered elevator shafts.
- H. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, or valve-tamper switch that is not readily visible from normal viewing position.

- I. Install ceiling mounted visible and audible/visible notification appliances in areas with exposed structure to bottom of floor/roof structure or at 30 ft AFF, whichever is lower.
- J. Install ceiling mounted visible and audible/visible notification appliances in areas with finished ceilings flush with bottom of ceiling or at 30 ft AFF, whichever is lower.
- K. Install wall mounted visible and audible/visible notification appliances with visible element (strobe) between 80 inches and 96 inches above finished floor unless noted otherwise on drawings.
- L. Install wall mounted audible devices with the top of the device at least 90 inches above finished floor or 6 inches below the ceiling, whichever is lower, unless noted otherwise on Drawings. If combination devices are installed, they shall be installed per the visible signal device requirements.
- M. All notification appliance speakers shall be tapped at $\frac{1}{2}$ watt unless noted otherwise on drawings. In rooms less than 100 sq ft, speakers are permitted to be tapped at $\frac{1}{4}$ watt.
- N. Mount outlet box for electric door holder to withstand 80 pounds (36.4 kg) pulling force.

3.4 PATHWAYS

- A. Pathways above suspended ceilings and in nonaccessible locations may be routed exposed where permitted by NFPA 70 & 72.
 - 1. Exposed pathways shall be installed in conduit.
- B. Pathways shall be installed in conduit.
- C. All detection and control circuits associated with smoke control systems shall be fully enclosed within continuous raceways.
- D. Minimum allowable conduit size shall be $\frac{3}{4}$ inch. The conduit shall be sized so that conduit fill does not exceed 75% of NFPA 70 maximum fill requirements. Cables in vertical risers shall not exceed 50% of NFPA 70 maximum fill requirements. Conduit installation shall be as required by the Contractor's layout and as described in these specifications. All conduit field routing shall be acceptable to the Owner. Routing not acceptable shall be rerouted and replaced without expense to the Owner.
- E. All wire, cable, conduit and raceways shall be concealed in walls, ceiling spaces, electrical shafts or closets in finished areas except as specifically noted otherwise. Conduit and raceways may be exposed in unfinished areas or where specifically approved by the Owner.
- F. Except as otherwise specified or indicated on the drawings, all conduit shall be installed parallel or perpendicular to dominant surfaces with right angle turns made of symmetrical bends or fittings. Except where prevented by the location of other work, a single conduit or a conduit group shall be centered on structural members.
- G. Conduit shall be located at least six inches from hot water or steam pipes, and from other hot surfaces. Conduit shall not block access to any existing equipment or fixtures.

- H. Mount end-of-line device in box with last device or separate box adjacent to last device in circuit for conventional hardwired class B initiating and notification appliance circuits.
- I. Conduit shall be securely fastened to all boxes and cabinets. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit. The locknuts both inside and outside shall then be tightened sufficiently to bond the conduit securely to the box. Conduit shall enter cabinets from the bottom and sides only.

3.5 CONNECTIONS

- A. All wiring shall be terminated at devices or panels using terminal connectors for screw type terminals. All terminal connectors for conductors shall be pre-insulated ring type or pre-insulated spade type. Pre-insulated terminal connectors shall include a vinyl sleeve, color coded to indicate conductor size. Pre-insulated terminal connectors shall include a metallic support sleeve bonded to the vinyl-insulating sleeve and designed to grip the conductor insulation.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Smoke dampers in air ducts of designated HVAC systems.
 - 2. Provide equipment and connections to shutdown fan powered air distribution equipment with an individual capacity less than or equal to 2,000 cfm that are part of an air distribution system with a design capacity greater than 2,000 cfm.
 - 3. Magnetically held-open doors.
 - 4. Electronically locked doors and access gates.
 - 5. Alarm initiating connection to elevator recall system and components.
 - 6. Alarm initiating connection to activate emergency lighting control.
 - 7. Connection to disable sound systems upon alarm activation.
 - 8. Supervisory connections at valve supervisory switches.

3.6 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.

3.7 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. All conduits and junction boxes shall be labeled as specified in Division 26 (red).
- C. The location of end-of-line resistors shall be identified with a label indicating "EOL."
- D. Provide label at each initiating device indicating the device address. Label shall be visible from the floor below or immediately adjacent to the device.

3.8 GROUNDING

- A. Ground fire alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.9 FIELD QUALITY CONTROL

- A. Systems shall be checked and tested in accordance with the instructions provided by the manufacturer to insure that the system functions as required and is free of grounds, opens, and shorts. Each device shall be tested.
 - 1. Smoke detectors shall be tested with products of combustion.
- B. Upon completion of the system installation and before the Date of Final Acceptance, a factory-trained technician shall perform all necessary tests and adjustments and shall then file a Letter of Certification and a Certificate of Completion (NFPA 72) with the Owner indicating that the system functions and conforms to the Fire Alarm System Specifications.
- C. Upon completion of the system installation, a factory-trained technician shall perform all necessary tests and adjustments in the presence of the Owner's designated personnel. Test in accordance with NFPA 72 and requirements of the authority having jurisdiction. Perform the following tests at a minimum:
 - 1. Visual Inspection: Conduct visual inspection prior to testing. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - a. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

- b. Test visible appliances for the public operating mode according to manufacturer's written instructions.
- D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- E. Fire alarm system will be considered defective if it does not pass tests and inspections.
- F. Include services of factory trained and certified technician to supervise installation, adjustments, final connections, and system testing as performed by the fire alarm contractor's factory-trained technicians.

3.10 DEMONSTRATION

- A. The equipment supplier's factory trained technician shall train the Owner's personnel in the proper use and maintenance of the system. Training sessions shall be conducted as needed, not to exceed a total of 2 sessions, with each session lasting a maximum of 4 hours each.
- B. Demonstrate normal and abnormal modes of operation, and required responses to each.

END OF SECTION 284600

SECTION 322000 – RESILIENT TRACK SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Division 31 Section “Earth Moving” for soils sterilization.
 - 2. Division 32 Section “Asphalt Paving for asphalt paving.

1.3 ENVIRONMENTAL REQUIREMENTS

- A. Weather: Construct resilient track surfacing only when the surface area is dry, the weather is not windy with no rain forecasted until after surfacing has cured, and the temperature of the material and ambient air is at least 45 deg F.

1.4 SUBMITTALS

- A. ASBA Certification: Submit documents to the Architect-Engineer certifying that the Contractor is currently a Certified Track Builder by ASBA for the installation of resilient track surfacing and asphalt tracks. Provide at least five projects where the Contractor has installed this type of track surfacing system. The installer shall be approved by the material supplier to install the track system. Provide reference projects, name, and contact phone number for representative track installations. If the installer has installed less than three tracks with the specified material, the material manufacturer shall have a representative on the site that has had experience in the installation of the type of track surfacing specified.
- B. Layout Certification: Submit documents to the Architect-Engineer certifying that the paint striping as installed meets the dimensions shown on the Drawings and The Course Measurement Requirements of Rule 5, Section 2, of the latest edition of the National Federation of State High School Associations Track and Field Rule Book.
- C. Track Event Layout Plan: Meet with the Owner (Athletic Director or Track Coach) to confirm event striping, event colors, text, and finish line location(s). Submit revised striping plan based on typical Track Striping Plan included as part of the Documents, reviewed and signed by the Owner. Submittals not signed by the Owner will not be accepted.

1.5 QUALITY ASSURANCE

- A. **Installer Qualifications:** An experienced installer (applicator) who has completed fluid-applied, resilient track surfacing similar in material, design, and extent to that indicated for this Project, that is acceptable to the manufacturer, and whose work has resulted in installations with a record of successful in-service performance.
- B. **Preinstallation Conference:** Conduct conference at the Project site. Comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to resilient track surfacing system including, but not limited to, the following:
 - 1. Review methods and procedures and asphalt installation requirements related to resilient track installation, with the asphalt installer and Owner, including manufacturer's written instructions.
 - 2. Coordinate with asphalt paving installer for asphalt surface tolerances to ensure asphalt substrate conditions and finishes are met for compliance with requirements, including flatness, slope, and imperfections.
 - 3. Be available on-site during asphalt paving installation and review track installation and any repair procedures after installation.

1.6 WARRANTY

- A. Resilient surfaces shall be warranted for a period of five years from the date of Substantial Completion against defects in materials and workmanship including defects such as delamination, bubbling, cracking, loss of integrity or excessive wear. The manufacturer shall review the asphalt pavement mix design and installation and accept the base before installation of the surfacing. The manufacturer shall immediately notify the Contractor and the Architect-Engineer of any deficiencies in the asphalt pavement mix design upon award of the Contract. The guarantee does not cover vandalism, neglect, improper care, improper care, improper footwear, or acts of God. The manufacturer's recommendations for maintenance shall be followed. The manufacturer shall submit full and complete maintenance instructions to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide Beynon Sports Surfaces, Inc.; BSS 100 Structurally Sprayed Black Mat System, or a comparable product by one of the following:
 - 1. Atlas Track & Tennis; 800-423-5875.
 - 2. Beynon Sports Surfaces, Inc.; 410-771-9473.
 - 3. Defargo.
 - 4. Fisher Tracks, Inc.; 515-432-3191.

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5. Hellas Construction, Inc.; SportTracks 200; 512-250-2910.
6. McConnell & Associates; 816-842-6066.
7. Tennis Surfaces Co.; 630-213-1163.
8. Vibra-Whirl, LTD.

2.2 STRUCTURALLY SPRAYED BLACK MAT SYSTEM

- A. Product: Poured in place polyurethane and rubber running track system. Industry standard thickness of 1/2 inch. Permeable running track system consists of the following:

1. Base primer.
2. EPDM or SBR rubber and polyurethane shock mat.
3. 2 mm textured coat.
4. Line striping.

- B. Materials:

1. Primers: Polyurethane based primers specifically formulated to be compatible with the base and track surfacing material.
2. Black SBR Granules: The rubber granules for the base mat shall be recycled SBR (styrene Butadiene Rubber) rubber, processed and chopped to 1-3 mm size containing less than 4% dust.
3. EPDM Granules: The rubber granules for the structural spray wearing coats shall be EPDM peroxide cured, man-made rubber containing a minimum of 20% EPDM and having a specific gravity of 1.5 ± 0.1 . The EPDM rubber will be 0.5mm to 1.5mm EPDM granules. EPDM granules shall be of the same color as chosen by the owner for the track surface.
4. Polyurethane Binder: Binder for the black rubber mat shall be an MDI-based mono-component, polyurethane binding agent. The binding agent shall not have a free TDI monomer level above 0.2%, must be clear in color, not milky, and must be solvent free. The binding agent must be specially formulated for compatibility with SBR stranded or rubber crumb.
5. Structural Spray Coating: The spray coating shall be the MDI-based mono-component, moisture cured, pigmented polyurethane, specifically formulated for compatibility with EPDM granules. The finish coat shall include ultraviolet inhibitors added to protect the surface. The coating shall be the color red.
6. Line Marking Paint: The line marking paint shall be polyurethane-based paint specifically manufactured to be compatible with polyurethane synthetic track surfaces.

- C. Execution:

1. Sub-Base: The Synthetic Track Surfacing System shall be laid on an approved asphalt substrate.
 - a. For Federation of National State High School Association's (NFHS) certification the following criteria must be followed. The track surface i.e., asphalt substrate, shall not vary from planned cross slope by more than + 0.1% with a maximum lateral slope outside to inside of 1% and a maximum slope of 0.1% in any running

- direction. The existing asphalt shall not vary under a 10' straight edge more than 1/4 inch.
- b. Any oil spills (hydraulic, diesel, motor oil, etc.) must be completely removed, either by chipping out or removing and replacing with new, keyed in asphalt. The minimum depth of any asphalt replacement shall be one inch. It shall be the responsibility of the surfacing contractor to determine if the asphalt substrate has cured sufficiently prior to the application of polyurethane surfacing system.
 - c. It shall be the responsibility of the Contractor to determine if the asphalt substrate meets all design specifications, i.e. cross, planarity and specific project criteria. After all the above conditions are met, the synthetic surfacing contractor must, in writing, accept the planarity of the asphalt-receiving base, before work can commence.
2. Curing: Before application of the synthetic surface can begin, all new asphalt patches shall be cured for at least 14 days, and a concrete base a minimum of 28 days.
 3. Cleaning: The area to be surfaced shall be clean and free of any loose or foreign particles (dirt, oil, etc.) prior to commencement of the work. The surface is usually cleaned by use of a power blower and/or high-pressure washer.
 4. Priming: The primer shall be spray-applied in accordance with the manufacturer's specifications. Only those areas that can be installed the same day should be primed.
 5. Mixture Composition: Job mix formulas shall be as follows:
 - a. Black Mat: Manufactured from polyurethane binder and industrial grade rubber. The polyurethane and rubber shall be mixed in a continuous mixer M-6000 at a ratio of 14.5 lb. EPDM rubber to 3.19 lb. of polyurethane. Bath mixing will not be allowed. Shock mat shall be applied with a sports paver specifically designed for running surfaces with a heated vibrating screed. SMG Plano Matic, 1993 or approved equal. Industrial grade rubber granules processed to a size of between 1mm to 4mm free of fabric and foreign material with less than 3% dust. Recycled tire rubber will not be allowed. Moisture content shall not be more than 3%.
 - b. Structural Spray Texture Coat: Using a structural spray machine, apply a mixture of polyurethane and EPDM rubber. This mixture shall be 60 parts colored polyurethane to 40 parts 0.5 mm to 1.5 mm rubber granules by weight. The polyurethane and rubber shall be completely mixed to insure complete encapsulation of each granule. Spray apply a minimum of 2 coats, each coat shall be 1.8 lb per square yard. The minimum amount of polyurethane and rubber for the spray coat shall be 3.6 lb. per square yard.
 6. Line Markings: All line and event markings shall be applied by experienced personnel utilizing two-part urethane-based paint compatible with the synthetic track surfacing. All marking dimensions will be certified in accordance with the specifications issued by the appropriate sanctioning or governing body such as IAAF, NCAA, NFSHSA, etc.
 - a. Engineer's pins shall be buried 9 inches deep at both radius points. All markings in the curves shall be laid out with a theodolite and shall be accurate to within 20 seconds of 1 degree. A typical transit is not considered suitable for layout. Straights shall be laid out and marked using a steel engineer's tape with proper allowances for temperature.

7. Physical Properties (ASTM):

- a. Thickness: 1/2 inch (12-13 mm) or as specified.
- b. Shore A Hardness (ASTM D-2240): 55 ± 5 .
- c. Elongation at Break (ASTM D-412): Approximately 90%.
- d. Tensile Strength (ASTM D-412): 0.75 N/mm^2 at 70 degrees F.
- e. Compression Set Recovery (ASTM D-412): 90% to 95% at 70 degrees F. over a 24-hour period.
- f. Abrasion Resistance (ASTM D-501): 0.25 grams loss after 1000 cycles.
- g. Chalking (ASTM D-822): No change after 1000 hours in weather meter.
- h. Coefficient of Friction (ASTM D-1984):
 - 1) Dry: 0.70 to 0.75.
 - 2) Wet: 0.60 to 0.65.
- i. Resilience (ASTM D-2632): 37% to 39%.
- j. Tear Resistance (ASTM D-624): 50 - 65 psi.
- k. Color: Red.

2.3 ASPHALT PAVEMENT

- A. Asphaltic base and leveling course shall meet specified tolerances prior to installation of resilient track surfacing.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install asphalt paving base and leveling course as specified on the Drawings. In addition to tolerances specified, continue testing of leveling course by flooding the surface with water. Remove roller marks and depressions that hold water deeper than the thickness of a nickel. Repair depressions by removing leveling course and replacing to specified levels. Grind roller marks to re-establish drainage. Repairs to the leveling course shall meet the requirements of the resilient paving manufacturer.
- B. Inspect existing paving base and patch surfaces for compatibility with new surfacing. Notify Architect in writing of any unsuitable conditions prior to surfacing installation. Installation of new surfacing constitutes surfacing installer's acceptance of substrate.
- C. Clean the surfaces to receive resilient track surfacing of oils, dirt, and material deleterious to the resilient track surfacing. Clean the surface using pressure washers. The Contractor shall coordinate who cleans the asphalt surface.
- D. Allow new asphalt to cure a minimum of 14 days or as required by the track surfacing manufacturer before laying resilient track surfacing.

- E. Notify the Architect-Engineer at least 72 hours in advance of initial laying of resilient track surfacing. The Architect-Engineer will be present at the jobsite during initial laydown operations.
- F. Lay resilient surfaces during daylight hours.
- G. Use high pressure blowers to remove dirt, dust, and debris from all surfaces to be coated with structural spray.
- H. A representative of the track surfacing manufacturer shall be present during layout operations.

3.2 INSTALLATION OF POLYURETHANE-BOUND RUBBERIZED SURFACING

- A. Provide a sharp cutting tool to cut back and remove existing track surfacing designated to be replaced.
- B. Spray on a polyurethane primer compatible with the asphalt base. Apply at rates recommended by the manufacturer. Mask areas which are not to be coated.
- C. Installation of the base mat shall be applied by mechanical means where possible, hand troweling smaller areas to be repaired is acceptable. The blended base materials shall be applied to the substrate using a mechanical screed finisher. The screed bar must be electronically heated. All hand rollers shall be electronically heated, if used.
- D. All joint work shall be troweled flush with adjacent base mat. Cured joints shall have their edges primed with the base mat priming agent prior to application of the base mat repair material.
- E. The pot life of the base mat material mixture shall be not less than 60 minutes from the time of the completed mix. All trowel work shall be completed within this time. Any areas that are rough, high, uneven, or open in texture shall be sanded and filled prior to any finish work and application of structural spray.
- F. Structural Spray Texture Coating: Using a structural spray machine, apply a mixture of polyurethane and EPDM rubber. Mixture shall be 60 parts colored polyurethane to 40 parts 0.55 mm to 1.5 mm rubber granules by weight. The polyurethane and rubber shall be completely mixed to ensure complete encapsulation of each granule. Spray a minimum of two (2) coats in two directions, 90 degrees from each other. Each coat shall be 1.8 lbs. per square yard. The minimum amount of polyurethane and rubber for the spray coat shall be 3.6 lbs. per square yard.
- G. Apply a final coat of U.V. resistant urethane at the rate of 0.05 gallon per square yard minimum.
- H. The above installation techniques are general in nature. The manufacturer's instructions shall be followed during installation.

3.3 LINE PAINTING

- A. Line painting shall be done by a workman experienced with the painting of track lines and the type of material being used. Clean the surface of dirt, grease, or other objectionable material. Actual painting of the lines shall be according to the manufacturer's requirements. Lines shall be sharp and free of overspray.

3.4 FIELD QUALITY CONTROL

- A. Test profile, grade, and tolerances of finished surface. Correct variations to meet the manufacturer's recommendations.
- B. Densities shall be according to the manufacturer's recommendations.

END OF SECTION 322000

SECTION 322100 – RUNNING TRACK TRENCH DRAIN SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes a precast, polymer concrete drain system designed for sports and running track installations.
- B. Furnish trench drainage system including all components and sub-components necessary to install system as shown on the drawings and as specified herein.
- C. Related Sections include the following:
 - 1. Section 033000 "Cast-in-Place Concrete" for concrete encasement of trench drain.
 - 2. Section 311000 "Earth Moving" for excavation and backfill.
 - 3. Section 322000 "Resilient Track Surfacing".
 - 4. Section 334100 "Storm Utility Drainage Piping".

1.3 DESIGN CRITERIA

- A. The design of trench drain systems shall be in accordance with specified design criteria, ASTM standard testing procedures, and generally accepted structural design practice.
- B. The design of the polymer concrete trench system and components shall be the responsibility of the manufacturer and shall be subject to approval by the Engineer or Architect.
- C. Design loads on drainage systems shall be AASHTO HS-20 loads.
- D. Where not otherwise specified, the tolerances and dimensions indicated by the manufacturer shall be considered acceptable.

1.4 SUBMITTALS

- A. Shop drawings for the complete system shall be completed by the manufacturer and submitted to the Architect or Engineer for approval.
- B. Manufacturer's catalog data showing:

1. Materials of construction.
2. Dimensions, spacing, and construction of trench system.
3. Installation guide.

1.5 QUALITY ASSURANCE

- A. Material covered by this section shall be furnished by a reputable and qualified manufacturer of proven ability who has regularly engaged in the manufacture and installation of sports and running track drainage systems.
- B. Substitution of any component or modification of system shall be made only when approved by the Architect or Engineer.
- C. Fabricator Qualifications: Firm experienced in successfully installing polymer concrete drainage systems similar to that indicated for this project.

PART 2 - PRODUCTS

2.1 PRECAST TRENCH DRAIN SYSTEM

- A. Track Straight Sections: The precast trench drain system shall be specifically designed for use with running tracks and shall be one of the following types and manufacturers or approved equal:
 1. SportsEdge PRO-S Channel Drain System with black ADA plastic herringbone grate; manufactured by SportsEdge; PO Box 231, Route 10, Delhi, NY 13753; phone 888-975-3343.
 2. ACO Sport System 4000 Trench Drain System with black ADA plastic grate; manufactured by ACO Polymer Products, Inc., Sports Division; 600 Hauze Way, Suite E-4, Roswell, GA 30076; phone 800-993-2738.
- B. Track "D" Areas: The precast polymer concrete slotted trench drain system shall be specifically designed for use with running tracks with in-line catch basin. Product shall be designed for track radius section and shall be compatible with the track trench drain for the trench drain on the straight-aways. The slot drain shall be one of the following types and manufacturers or approved equal:
 1. SportsEdge Linear XT-6 Slot Drain System; manufactured by SportsEdge; PO Box 231, Route 10, Delhi, NY 13753; phone 888-975-3343.
 2. ACO Sport System 2000 Slotted Linear Drain System; manufactured by ACO Polymer Products, Inc., Sports Division; 600 Hauze Way, Suite E-4, Roswell, GA 30076; phone 800-993-2738.

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2.2 MATERIALS, GENERAL

- A. Materials used in the manufacturing of trench drain systems shall be first-run product of the best quality and shall be free from all defects and imperfections that might affect the performance of the finished product.
- B. All materials shall be of the kind and quality specified. Where the quality is not specified, it shall be the best of the respective kinds and suitable for the purpose intended.
- C. Slotted linear drain channels shall be precast polymer concrete formed with a matching metal tooling utilizing a polyester resin or high-density polymer trench system with integral clips, joint connectors, and 6-inch by 20-inch catch basins integral to the system.

2.3 TRENCH DRAIN CHANNELS AND OUTLET SUMPS

- A. Channels must be 5.7- inches (146 mm) minimum diameter (inside dimensions) and shall be provided with tongue and groove ends and shall interlock fully and evenly with adjoining channels.
- B. Outlet sump catch basin will be integral to the drain system with a minimum of two 6-inch diameter knock-out openings for PVC outlet drain to HDPE collector pipe.
 - 1. Provide and install eight (8) outlet sumps minimum as shown on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The drain system shall be installed in strict accordance with manufacturer's recommendations and approved shop drawings.
- B. Channel placement shall begin at the catch basins.
- C. Connect outlet sumps to 10-inch diameter HDPE and track collector drainpipe per manufacturer's recommendations.
- D. All connections shall be soil tight.

3.2 INSPECTION

- A. The Engineer shall have the right to inspect and test all materials to be furnished under these specifications prior to their shipment from the point of manufacturer.
- B. All labor, power, materials, equipment and appurtenances required for testing shall be furnished by the Contractor at no cost to the Owner.

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PACKAGE 3 – BUILDING & SITE
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13-20102-00
8 OCTOBER 2020
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END OF SECTION 322100

RUNNING TRACK TRENCH DRAIN SYSTEM

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SECTION 322200 – SYNTHETIC TURF BASE CONSTRUCTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Work included in this Section includes design, procurement, and installation of drainage aggregate base, utility/communication boxes, geotextile fabric, and sub-drain system for new synthetic playing field systems for football and soccer fields.
- B. Furnish and install perforated HDPE pipe in sand jump pits per the Drawings.
- C. Related Sections: The following Sections contain requirements that relate to this Section.
 - 1. Section 033000 "Cast-in-Place Concrete."
 - 2. Section 116803 "Athletic Equipment" for goal posts.
 - 3. Section 311000 "Site Clearing."
 - 4. Section 312000 "Earthwork" for analysis of existing soil conditions at the location of the synthetic playing field system; fly ash stabilization, and for excavation, filling and backfilling, and rough grading.
 - 5. Section 322001 "Synthetic Turf Surfacing" for turf surfacing system.

1.3 SYSTEM DESCRIPTION

- A. General: Base construction to accommodate an infilled synthetic turf playing field system.
 - 1. Components include, but are not limited to:
 - a. Earthwork Requirements:
 - 1) Excavation, trenching, grading, filling, backfilling, and compaction.
 - 2) Disposal of spoil materials.
 - b. Porous aggregate layer.
 - c. Subdrainage System:
 - 1) Filter fabric.
 - 2) Gravel and drainage material.
 - 3) Composite drain, collector drain, main line pipe and fittings.

- d. Graded and compacted subgrade.
- e. Installation of field communication boxes and goal post components

1.4 PROJECT CONDITIONS

- A. Site Information: Data in Geotechnical Exploration report was used for the basis of the design and is available from the Architect for review. Contractor will be responsible for obtaining a copy of the report, and for interpretations and conclusions drawn from this report.
 - 1. Contractor may perform additional test borings and other exploratory operations, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.
- B. Use of Explosives: Use of explosives is not permitted.
- C. Protection of Persons and Property: Barricade open excavations occurring as part of this Work and post with warning lights.
 - 1. Operate warning lights as recommended by authorities having jurisdiction.
 - 2. Protect structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- D. Existing Benchmarks: Carefully preserve and maintain existing benchmarks, vertical/horizontal control, monuments, property line pipes and pins, and other reference points. If disturbed or destroyed, restore or replace at no additional cost to the Owner.
- E. Field Measurements: Each bidder is encouraged to visit the site of the Work to verify the existing conditions. No adjustments will be made to the Contract Sum for variations in the existing conditions.
 - 1. Establish and verify connections/outfalls to existing storm drainage systems prior to submission of bid.
- F. Environmental Limitations: Do not delivery surfacing material if either ambient air temperature or material temperature is below 32 degrees F.
 - 1. Do not proceed with installation until weather conditions are satisfactory according to the manufacturer's recommendations.
 - 2. Polyethylene Pipe Installation: Pipe shall be installed in dry weather when temperature is above 40 degrees F.

1.5 SUBMITTALS

- A. Product Data: For each product specified. Include details of construction relative to materials, dimension of individual components.
 - 1. Submit manufacturer's product data on drainage pipe material and geotextile fabric.

2. Base Stone aggregate gradation report, and 1 lb. sample
 3. Surface course gradation report and 1 lb. sample.
 4. Test Results:
 - a. Gravel Base Material: Provide a one-gallon sample of each 500-ton lot of gravel to testing lab for testing.
 - b. Gravel Surface Course: Provide a one-gallon sample of each 500-ton lot of gravel to testing lab for testing.
- B. Quality Assurance Information:
1. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
 - a. Provide a list of existing synthetic turf field installations, including owner representative and telephone number for each.
- C. Product Test Reports: Based on evaluation of tests performed by manufacturer and witnessed by a qualified independent testing agency, indicate compliance of surfacing material with requirements based on comprehensive testing of current systems.
- D. Installer Qualifications: Contractor/Installer shall be certified and a member in good standing with American Sports Builders Association (ASBA). Submit certification documents.
- E. Shop Drawings: Show detail of installation, including plans, sections, and interfaces with existing construction.
- F. Field Quality Control Test Results: Provide results of field quality control tests within 3 days of testing for each of the tests specified.
- G. Maintenance Instructions: Submit to the Owner three copies of manufacturer's printed instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under anticipated use conditions. Include precautions against all materials and methods that may be detrimental to finishes and performance.
- H. Field Conformance Surveys: Submit certified survey by professional Surveyor of topographic surface of the completed sub-grade at 25-feet on center, and surface of drainage aggregate at 10-feet on center.
- I. Provide Record Drawings of topographic surface of completed aggregate surface with spot elevations at 10-feet on center, maximum.
- J. Certified As-Built Surveys: Submit three copies of as-built field and drainage improvements, sealed by professional surveyor in the state of Kansas.
- K. Prior to the beginning of installation, the manufacturer/installer of the synthetic turf shall inspect the aggregate surface course and supply a Certificate of Acceptance for the purpose of obtaining manufacturer's warranty for the finished synthetic playing surface.

1.6 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner or other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: Submit a written warranty executed by the manufacturer and installer agreeing to repair or replace components of synthetic surfacing that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, the following:
 - 1. Failure of system to meet performance requirements.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm that complies with the following requirements and is experienced in manufacturing synthetic playing surface materials similar to those indicated for this Project and with a record of successful in-service performance.
 - 1. Assumes responsibility for engineering synthetic playing surface components to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive analysis by a qualified professional engineer.
 - 2. Has provided synthetic playing surface components for at least 30 athletic fields at the high school level or higher.
 - 3. Has sufficient production capacity to produce required materials without delaying the Work.
- B. Professional Surveyor Qualifications: A professional surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing services of the kind indicated.
- C. Soil Testing and Observation Service: Owner will employ and pay for qualified independent geotechnical testing and observation laboratory to perform soil testing and observation service during earthwork operations. Provide necessary means to assure cooperation with testing firm.
- D. Qualifications for Subgrade Installer: Engage experienced installer to perform this Section who, in the past 5 years, has installed at least 5 subgrades for synthetic playing fields similar to that required for this Project and who is acceptable to the manufacturer of the synthetic playing field surface.
- E. Playing field surface shall be manufactured, located and installed in strict compliance with National Federation of State High School Associations (NFSHSA) Rules and Regulations for Football and Soccer.
- F. Pre-Installation Conference: Conduct conference at the job site for coordination of schedule, access, procedures and security with the Owner, Architect, Construction Manager, Contractor and other related subcontractors.

- G. Testing and Verification: Contractor to send sand and drainage aggregate samples to:
1. Turf Diagnostics and Design; 613 East 1st Street; Linwood KS 66052; telephone 913-723-3700; fax 913-723-3701; contact Sam Ferro.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle materials under the provisions of Division 01 sections.
- B. Stockpile material near installation area.
- C. Material will be inspected upon delivery to site.
- D. Remove unacceptable materials from site immediately.

PART 2 - PRODUCTS

2.1 SUBSOIL MATERIALS

- A. General: All fill material, regardless of intended use category, shall be clean and free from organic matter, roots, brush or other vegetation, trash, debris or other detrimental substances, and rocks or unbroken lumps larger than 3 inches, and shall be tested and approved by the soil testing and observation agency prior to placement.
- B. Trench Backfill: Existing soils obtained from playing field system excavations, excluding broken and pulverized weathered bedrock.
- C. Unacceptable Soil Materials: Existing on-site material or asphalt materials not suitable for fill.

2.2 DRAINAGE OF SYSTEM MATERIALS

- A. Aggregate Drainage Material: The gravel shall consist of clean crushed stone that meets the following criteria. Gravel components shall not exceed 12 percent loss of materials as determined by a sulfate soundness test (ASTM C 88). The gravel shall be installed in two layers to the thickness indicated on the Drawings. The gravel shall confirm to the following:

Sieve Size	Base Course Percent Passing	Finish Course Percent Passing
1.00 inch	100	
3/4 inch	90 – 100	
3/8 inch	40 – 100	
1/4 inch		65
3/16" inch		50

Sieve Size	Base Course Percent Passing	Finish Course Percent Passing
1/8 inch		35
1/16 inch		25
#4	25 – 40	
#8	18-33	
#30	5-15	
#50	0 – 7	
#200	0 – 3	5

- B. Collector Drains: Perforated dual wall corrugated exterior, smooth wall interior high-density polyethylene pipe (HDPE) N-12 pipe meeting requirements for Type S pipe; ASHTO M225CP, for 4-inch to 10-inch diameters; and ASHTO M252 for 12-inch to 36-inch diameters. Provide drainage pipe complete with bends, reducers, adapters, couplings, collars, and joint materials. Perforated pipe shall have a minimum inlet area equal to 1.5 square inches per linear foot of pipe.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advantage Drainage System (ADS).
 - b. Hancor, Inc.
 - c. Timewell.
- C. Composite Panel Drains: Pipe shall meet ASTM D 695, D 1621. The pipe; 1-inch by 12-inch flat panel pipe. The pipe shall be perforated utilizing knife slots configuration. The perforated pipe shall have a minimum inlet area equal to 10 square inches per linear foot of pipe. Provide pipe complete with adapters, couplers, caps, collars, and joint materials as may be required for installation and connection to collector pipe.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. AdvanEDGE Drainage System (ADS).
 - b. Hancor, Inc.
 - c. Hydra-Way
 - d. Multi-flow.
- D. Clean Out: Provide clean out fittings fabricated from ASHTO-M252 polyethylene pipe that includes threaded polyethylene cap.
- E. Geotextile Filter Fabric: Nonwoven filter fabric consisting of long-chain synthetic polymers, composed of at least 85 percent by weight polyolefins, polyesters, or polyamides and exhibiting the following physical properties:

Test	Performance	Reference Standard
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Test	Performance	Reference Standard
Grab Strength	90 lb. minimum	ASTM D 4632
Puncture Resistance	50 lb. minimum	ASTM D 4833
Mullen Burst Strength	195 psi minimum	ASTM D 3786
Trapezoid Tear Strength	40 lb. minimum	ASTM D 4533
Permeability	0.1 cm/sec. minimum	ASTM D 4491
Apparent Opening Size	#50 sieve size	ASTM D 4751

2.3 COMMUNICATION BOXES

- A. Product: Subject to compliance with requirements, provide the following or approved equal.
1. Sportsfield Specialties; 3500 Series Combox Plus for synthetic turf.
- B. Description:
1. The utility box shall be constructed of structural aluminum.
 2. Divider plate to separate power from communications.
 3. Cover designed to accept either track surfacing or synthetic turf with infill.
 4. Quick access plug-in type covers.
 5. Rubber edge on covers to retain infill as required.
 6. Size: 18 inches wide by 30 inches length minimum or size as noted on the Drawings.

PART 3 - EXECUTION

3.1 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, relative to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.
- B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
1. Establish benchmarks and control points to set lines and levels as necessary to locate each element of Project.
 2. Establish dimensions within tolerance indicated. Do not scale Drawings to obtain required dimensions.
 3. Inform installers of lines and levels to which they must comply.
 4. Check the location and level of every major element as the Work progresses.
 5. Notify Architect when deviations from required lines and level exceed allowable tolerance.
 6. Close site surveys with an error closure equal to or less than the standard established by authorities having jurisdiction.

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- C. Site Improvements: Locate and lay out site improvements, including grading, fill and topsoil placement, utility slopes, and invert elevations.
- D. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.2 EARTHWORK EXECUTION

- A. General: Remove material of every nature of description encountered in obtaining required lines and grades. Excavate and/or place and compact fill to provide for elevation(s) required by Drawings. Excavation is considered unclassified and includes exaction to subgrade elevations indicated, regardless of character of materials and obstructions encountered.
 - 1. Conform to elevations and grades indicated on Drawings within a tolerance of $\pm 1/2$ inch in 25 feet in either direction.
- B. Drainage System and Conduit Trenching: Dig trenches to depth and width indicated on the Drawings. Abnormal conditions such as large cobbles or unstable conditions that may cause trench to lose integrity shall be reported to Architect immediately. Excavate trenches to uniform width, sufficiently wide to provide ample working room and a minimum width of twice the pipe diameter.
 - 1. Excavate trenches and conduit to depth indicated or required to establish indicated slope and invert elevations and to support bottom of pipe or conduit on undisturbed soil.
 - 2. Only perform trenching, pipe or conduit installation and backfilling operations that can be completed in one day. Crib or brace trenches to prevent cave-in. Exposed trenches that collapse due to rain or other occurrences shall be widened and filled as specified or refilled with subgrade materials, compacted and retrenched.
 - 3. Compact the bottoms of all trenches to the density described in this Section for placement and compaction.

3.3 PLACEMENT AND COMPACTION OF SOIL MATERIALS

- A. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills.
 - 1. When existing subgrade ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface. Scarify existing subgrade to depth of 8 inches prior to compacting. Moisture condition between 3 percent below and 2 percent above optimum moisture content, and recompact to at least 95 percent of standard Proctor density (ASTM D 698).
 - 2. In addition to density sampling, Contractor to proof-roll entire subgrade with pneumatic-tired vehicle that has a gross weight of 50,000 pounds with a single axle weight of 18,000 pounds and tire pressure of 100 psi. If soft spots are encountered, contractor to scarify, recompact and re-grade as necessary.

- B. Before compaction of subgrade, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- C. Failings: If, based on the testing and observation agency reports and observations, compacted subgrade or fillers are found to be below specified density, provide additional compaction and testing in accordance with specifications.
- D. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structure or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each life.
 - 1. Subgrade Ground Surface and Bottom of Trench Compaction Requirements: Compact soil to not less than 95 percent of standard Proctor density, with a moisture condition between 3 percent below and 2 percent above optimum moisture content in accordance with ASTM D 698.
- E. Moisture Control: Where subgrade soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.
 - 1. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
- F. Sub-Grade Conformance Verification: A certified survey shall be performed at 25-foot centers to verify grade and elevation of the subgrade.

3.4 FIELD DRAINAGE INSTALLATION

- A. Subgrade Grading: Shape surface of areas under gravel drainage material to line, grade, and cross-section, with finish surface not more than 1/2 inch in 25 feet either direction above or below required subgrade elevation.
 - 1. The Contractor shall utilize laser-controlled equipment for subgrade grading to ensure accuracy in grading tolerances.
- B. Installation of Geotextile Filter Fabric: Install filter fabric on bottom and sides of trenches and over entire surface of playing field subgrade. Overlap fabric a minimum of 12 inches at each side of trenches on top of the subgrade.
- C. Laying Pipe Materials: Provide full bearing for each pipe section throughout its length with drainage fill material to true grades and alignment and continuous slope in direction of flow.
 - 1. Lay perforated pipe in accordance with pipe manufacturer's recommendations. Provide collars and couplings as required.

2. Install locator tape around or on the drainage pipe for future detection after field installation is complete.
- D. Clean Out: Cap shall be recessed 12 inches below finish grade of field or as indicated on the Drawings. Install bolt, washer and nut on cap for metal detection purposes.
- E. ComBoxes: Provide PVC drainage pipe connection from the box drainage outlet to the collector drain pipe system in the field.
- F. Testing Drain Lines: Test or check lines before placing drainage fill material to assure free flow. Remove obstructions, replace damaged components, and retest system until satisfactory.
- G. Drainage Fill: Place drainage fill material after testing of drainage system in a single layer. Place material around drainage pipe located in French areas until drainage material is level with the surrounding subgrade. After filling of trench areas, place drainage fill to depth above subgrade shown in the Drawings.
- H. Backfilling: Do not completely backfill trenches until tests and observations have been made and backfilling is authorized by Engineer. Do not use compaction equipment directly over drain lines until sufficient backfill has been placed to ensure that such equipment will not damage or disturb drainage lines.
- I. Final Grade: Shape the finish course surface of gravel drainage material to grade and cross-section indicated, with a finish surface not more than 1/4 inch in length of 25 feet in any direction.
 1. The Contractor shall utilize laser-controlled equipment for the grading of the drainage fill material to ensure accuracy in grading tolerances.
 2. Fill in any low areas with finish course aggregate material or clean course sand and verify grade with additional survey.
- J. Aggregate Base Conformance Verification: A certified survey shall be performed at 10-foot centers to verify grade and elevation of the gravel drainage blanket layer above the subgrade.
- K. Coordination: Coordinate connection of perimeter track drain system, collector drainpipe, and long jump pit drainage pipe to extend to the storm sewer system or as shown on the Drawings.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor shall engage a qualified independent testing agency to perform field quality-control testing.
- B. Testing agency shall inspect and test the following:
 1. Subgrades and each fill or backfill layer.
 2. Compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable.
 3. Surface performance requirements.

- 4. Surface impact and shock absorbency according to ASTM F 1936 and ASTM F 355.
- C. Proceed with subsequent work only after test results for previously completed work comply with requirements.
- D. When testing agency reports that subgrades have not achieve degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.6 WARRANTY MAINTENANCE

- A. As a condition of the warranty, Contractor shall review the condition of the playing surface on a yearly basis to evaluate Owner's maintenance protocols.
- B. Testing Agency: Contractor shall engage a qualified independent testing and inspecting agency to perform tests and inspections throughout the duration of the warranty, and to prepare test reports, to ensure satisfactory performance.

3.7 CLEANING AND PROTECTING

- A. Cleaning: Upon completion of installation, clean all playing surfaces so they are free of foreign matter.
- B. Provide final protection and maintain conditions in a manner acceptable to manufacturer and installer that ensure playing surface is without damage or deterioration at the time of Substantial Completion.

END OF SECTION 322200

SECTION 322201 –SYNTHETIC TURF SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Work included in this Section includes design, procurement, and installation of a new synthetic playing field system for the football field and soccer field markings.
- B. Related Sections: The following Sections contain requirements that relate to this Section.
 - 1. Section 033000 "Cast-in-Place Concrete" for concrete field edge curbs, concrete slabs, and base anchors.
 - 2. Section 116803 "Athletic Equipment" for ballfield bases, home plates, and pitching rubbers.
 - 3. Section 312000 "Earthwork" for analysis of existing soil conditions at the location of the synthetic playing field system; and for excavation, filling and backfilling, and rough grading.
 - 4. Section 311000 "Site Clearing."
 - 5. Section 322200 "Synthetic Turf Base Construction" for subgrade compaction, drainage aggregate, and comboxes.

1.3 SYSTEM DESCRIPTION

- A. General: Synthetic playing field system shall be comprised of subgrade drainage system and synthetic turf with infill material of ground rubber or sand as applies.
 - 1. Components include, but are not limited to:
 - a. Turf Installation:
 - 1) Inspect gravel and concrete base for grade and compaction, and perimeter curb grade and finish for turf attachment.
 - 2) Complete installation of turf including sewing seams, inlaid lines and markings, installation of infill materials, installation of turf on top of communication boxes, around goal posts, track events, etc.
 - 3) Provide confirmation of aggregate base planarity with use of a string line from the crown or slope of the field surface or by other approved means and make any necessary corrections.

1.4 PROJECT CONDITIONS

- A. Site Information: Turf Contractor is responsible for inspecting gravel drainage base and approving compaction and surface conditions prior to turf installation. Commencing turf installation implies that turf contractor has accepted gravel drainage base.
 - 1. Contractor may perform additional surveys, rolling, or addition/removal of finish aggregate layer to provide gravel base surface planarity per requirements of “Synthetic Turf Base.”
- B. Protection of Persons and Property: Barricade open excavations occurring as part of this Work and post with warning lights.
 - 1. Operate warning lights as recommended by authorities having jurisdiction.
 - 2. Protect structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- C. Existing Benchmarks: Carefully preserve and maintain existing benchmarks, vertical/horizontal control, monuments, property line pipes and pins, and other reference points. If disturbed or destroyed, restore or replace at no additional cost to the Owner.
- D. Field Measurements: Each bidder is encouraged to visit the site of the Work to verify the existing conditions. No adjustments will be made to the Contract Sum for variations in the existing conditions.
- E. Environmental Limitations: Do not delivery surfacing material if either ambient air temperature or material temperature is below 32 degrees F.
 - 1. Do not proceed with installation until weather conditions are satisfactory according to the manufacturer’s recommendations.

1.5 SUBMITTALS REQUIRED AFTER AWARD OF CONTRACT

- A. Product Data: For each product specified. Include details of construction relative to materials and dimensions of individual components.
 - 1. Submit manufacturer’s product data on sports field grooming equipment.
- B. Samples: Provide samples of the following components:
 - 1. Synthetic Turf Field and Inlays: 7 inches by 11 inches, and striping colors.
 - 2. Synthetic Turf Striping: 6 inches minimum.
 - 3. Sewn Seams: 6 inches minimum.
 - 4. Infill Materials: 1 quart each.
- C. Quality Assurance Information:

1. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
 - a. Provide a list of existing installations, including owner representative and telephone number for each.
- D. Product Test Reports: Based on evaluation of tests performed by manufacturer and witnessed by a qualified independent testing agency, indicate compliance of surfacing material with requirements based on comprehensive testing of current systems.
- E. Installer Qualifications: Contractor's superintendent shall be a Certified Field Builder and a member in good standing with American Sports Builders Association (ASBA). This individual shall be on site continuously during synthetic turf field and subgrade installation activities. Submit certification documents.
- F. Shop Drawings: Show detail of installation, including plans, sections, and interfaces with existing construction.
 1. Provide details of all edge conditions for playing surface.
 2. Provide details for all logos, numbers, and field markings. Architect will provide electronic graphic information for use in preparing shop drawings.
 3. Provide seaming plan.
 4. Provide striping plan.
- G. Maintenance Instructions: Submit to the Owner three copies of manufacturer's printed instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under anticipated use conditions. Include precautions against all materials and methods that may be detrimental to finishes and performance.
 1. The turf installer/supplier shall provide on-site maintenance training for the Owner's maintenance personnel on how to maintain the field properly for time as required to fully demonstrating proper field maintenance.
- H. Provide As-Built Record Drawings of topographic surface of completed playing surface, utilities and drainage improvements with spot elevations at 10 feet on center, maximum.
- I. Certified Surveys: Submit three (3) copies of as-built field and drainage improvements, sealed by a licensed professional engineer responsible for their preparation.
- J. Prior to the beginning of installation, the manufacturer/installer of the synthetic turf shall inspect the aggregate surface course and supply a Certificate of Acceptance for the purpose of obtaining manufacturer's warranty for the finished synthetic playing surface.
- K. Environmental: Provide third party material testing confirming that turf and infill rubber meets or exceeds Federal requirements for consumer products safety.

1.6 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner or other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: Submit a written warranty by the manufacturer and installer executed by an approved third-party entity agreeing to repair or replace components of synthetic surfacing or base materials that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, the following:
 - 1. Premature wear and tear provided the material is maintained in accordance with manufacturer's written maintenance instructions.
 - 2. Seam failure, including delaminating, raveling, and separation.
 - 3. Settling of the base aggregate.
 - 4. Failure of system to meet performance requirements.
 - 5. Impact attenuation G_{max} shall not exceed 150.
- C. Warranty Period: Eight years from date of Substantial Completion.
 - 1. Conditions: Yearly inspections shall be performed to maintain warranty. G_{max} testing per ASTM F355 shall be performed at years 1, 3, 5 and 7 to maintain warranty.
 - 2. Aggregate Base and Subdrainage System: 8 years from Substantial Completion.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm that complies with the following requirements and is experienced in manufacturing synthetic playing surface materials similar to those indicated for this Project and with a record of successful in-service performance.
 - 1. Assumes responsibility for engineering synthetic playing surface components to comply with performance requirements.
 - 2. Has provided synthetic playing surface components for at least 30 athletic fields at the high school level or higher.
 - 3. Has sufficient production capacity to produce required materials without delaying the Work.
- B. Installer Qualifications: Engage an experienced installer to perform work of this Section who, in the past 5 years, has installed at least 10 synthetic playing field systems similar to that required for this Project and who is acceptable to the manufacturer.
 - 1. Installer Certificates: Provide a list of a minimum of ten similar existing field installations, completed over the past five years, including contact information, including telephone number, for the Owner's representative for each project.
 - 2. Installer shall provide 24-hour call back for warranty work and 48-hours for site visit and/or commencement of warranty repairs.

- C. Playing field surfaces shall be manufactured, located and installed in strict compliance with National Federation of State High School Associations (NFSHSA) Rules and Regulations for Baseball and Softball fields.
- D. Pre-Installation Conference: Conduct conference at the job site for coordination of schedule, access, procedures and security with the Owner, Architect, Construction Manager, Contractor and other related subcontractors.

PART 2 - PRODUCTS

2.1 SYNTHETIC TURF SURFACING

- A. Basis-of-Design Product: Subject to compliance with requirements, provide basis of Design RamTurf Dual Fiber turf polymer with XP Fiber Technology and fully UV stabilized system, or equal product by one of the following:
 - 1. Act Global.
 - 2. AstroTurf
 - 3. Hellas Turf.
 - 4. MondoTurf.
 - 5. Shaw Sports Turf.
 - 6. SportTurf.
 - 7. Greenfields.
- B. Baseball/Softball Product Requirements:
 - 1. Fiber Denier: 10,800/6 dtex minimum.
 - 2. Structure: Blend of 50% three-dimensional monofilament fiber and 50% slit-film turf fibers.
 - 3. Monofilament Thickness: Minimum 360 microns.
 - 4. Slit Film Yarn Thickness: Minimum 250 and 150 microns.
 - 5. Filament Width: 1.20 mm.
 - 6. UV Protection: Fiber embedded XP™ technology or approved equal.
 - 7. Yarn Tensile Strength: 135 N minimum.
 - 8. Face Weight: 48-50 oz. minimum
 - 9. Tuft Gauge: 3/8-inch.
 - 10. Green Turf Pile Height: 2-inch minimum turf height consistent height throughout material.
 - 11. Infield/Warning Track Pile Height: 1-5/8 inches to 1-7/8 inches maximum, consistent height throughout material.
 - 12. Primary Backing: Two-part minimum composite, comprised of both woven and non-woven components.
 - 13. Primary Backing Weight: 12 oz/sq. yd. minimum.
 - 14. Primary Backing Dimensional Stability: 47.10 N/square meter.

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15. Secondary Backing Coating: Solid polyurethane.
16. Secondary Backing Coating Weight: 23 oz/square yard minimum.
17. Backing Tear Strength: Grab Tear Strength (X-Y) > 350-500 lb.
18. Perforated Backing: ¼-inch minimum holes at 4 inches on center in both directions.
19. Tuft Bind Pull-out: 9 lbs.

2.2 SYSTEM COMPONENTS

- A. Synthetic Turf: Polyethylene fibers tufted into a permeable multiple-layered primary backing with a secondary backing.
 1. Surfacing material shall have qualities including, but not limited to, the following:
 - a. Resistance to insect, vermin, rot, mildew, fungus growth.
 - b. Non-toxic components.
 - c. Traction with conventional athletic shoes, without cleats.
 - d. Stabilized to resist the effects of ultraviolet degradation.
 2. Baseball/Softball Turf Fiber Colors:
 - a. Play Fields: Color blend of “Field Green and “Lime Green” or as selected by the Architect and Owner from manufacturer’s full range of turf colors.
 - b. Baseball/Softball Infield and Warning Track Color: “Reddish Brown” or “Clay” as selected by the Architect and Owner from manufacturer’s full range of turf colors.
 - c. Refer to Drawings for field layouts, striping, field logos, and colors.
- B. Infill Mix: Baseball/Softball Infield and Outfield.
 1. Sand:
 - a. Siliceous (95%) washed and dried.
 - b. Round grain shape.
 - c. Size: 0.5-1.2 mm
 - d. 3-4 lbs./sq. ft. minimum.
 2. Rubber:
 - a. Provide 100 percent ambient or cryogenic ground SBR ground rubber pellets.
 - b. No evidence of metal fragments.
 - c. Size: 0.5-1.8 mm. (1% less than 0.5 mm).
 - d. 3-4 lbs./sq. ft. minimum.
 3. Sand and rubber proportions shall be per manufacturer’s recommendations and meet performance criteria herein defined.

- C. Synthetic Turf Warning Track: Provide and install a blend of washed round clean course sand/gravel material with grain shape in size 0.8 to 1.4 mm diameter and SBR rubber pellets. Mix shall have a successful record with warning track turf systems. Provide 90% sand and 10% rubber at 6-8 lbs./sq. ft., or at rate recommended by turf manufacturer.
1. Apply infill mix as required to obtain a 1.70-inch minimum depth or as recommended by manufacturer.
 2. Submit materials analysis and testing to confirm silt, clay, and other deleterious materials are less than 0.05 percent by volume. Silt and clay are not acceptable for infill.
 3. SBR crumb rubber in 0.5 to 1.2mm size closely matching sand gradation.
- D. Turf Seams:
1. All seams between rolls of turf are to be either sewn per manufacturer recommendations.
 2. Inlay lines and markings may be sheared and adhered with special hot melt adhesive specifically designed for artificial turf and approved for use by turf manufacturer.
 3. Adhesive shall be a water-based adhesive specifically designed for artificial turf and approved for use by turf manufacturer.

2.3 EXTRA MATERIALS

- A. Provide two SuperSacks of SBR Crumb Rubber infill material containing approximately 1,750 lbs. each of crumb rubber.
- B. Provide two SuperSacks of natural sand infill material containing approximately 1,750 lbs. of infill.

2.4 SPECIAL MAINTENANCE EQUIPMENT

- A. General: Provide special materials, tools, and equipment, as recommended by the synthetic material manufacturer, required for maintenance of the playing surface based on the conditions of the manufacturer's warranty.
1. Field Grooming Equipment:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide GreensGroomer; Model 920SDE synthetic turf sports field groomer with tow hitch package.
 - 1) Groomer Equipment: Non-motorized unit measuring 72 inches wide by 48 inches long, (not including the draw bar).
 - 2) Mobility: Designed to be pulled with an ATV. Unit has two pneumatic tires and incorporates an electric lift for raising and lowering.
 - 3) Provides a minimum of 164 linear inches of brushes configured in 4 distinct angles.
 - 4) Overall Weight: 260 lbs. and is measured at 0.24lbs/psi.

2. Synthetic Turf Sweeper/Debris Collector with Sports Field Magnet:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide GreensGroomer; LitterKat Model 760 unit that is towable and non-motorized.
 - 1) Unit Size: Constructed of steel with 87-inch frame including the wheels. Depth of unit is 42 inches; height is 20.5 inches.
 - 2) Provide two 33-inch-long by 10-inch-diameter nylon bristle brushes powered by a ground driven, direct drive gear with rigid gear guards. A 12V actuator raises and lowers the unit for use or transport.
 - 3) Provides two perforated collection baskets at 31-inch length by 35.5-inch width by 9-inch diameter-. Each basket has a 12V vibrator to re-distribute infill. The removable draw bar is 56 inches long by 3 inches diameter steel.
 - 4) Weight: 447 lbs.

3. Synthetic Turf Magnet:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide GreensGroomer; Synthetic Turf Magnet in a towable unit.
 - 1) Draw Bar: 36-inch length situated on a frame that rides on two pneumatic 2.80/2.50-4 4-ply tires.
 - 2) Dimensions: 72-inch width by 5-inches length by 2-inches height. The magnet provides 360 sq. inches of surface. Strength of the magnet is 670 lbs. pull. The weight of the complete unit is 102 lbs.

- B. Provide training for Owner's maintenance personnel.

2.5 FIELD MARKINGS

- A. General: Field markings shall be as indicated on the Drawings or per NFHS minimum standards.
- B. Markings, including yard lines, numbers, and perimeter markings, shall be tufted into the playing surface using polypropylene fibers. Painting of markings will not be allowed.
 - 1. Colors: Baseball/Softball Fields: White.
 - 2. Width: 4 inches, unless otherwise indicated on the Drawings.

2.6 QUALITY CONTROL IN MANUFACTURING

- A. The manufacturer shall have full-time certified in-house inspectors at their manufacturing plant that are experts with industry standards.
- B. The manufacturer's full-time in-house certified inspectors shall perform pre-tufting fiber testing on tensile strength, elongation, tenacity, denier, shrinkage, and twist i.e., turns per inch, upon receipt of fiber spools from fiber manufacturer.

- C. Primary backing shall be inspected by the manufacturer's full-time certified in-house inspectors before tufting begins.
- D. The manufacturer's full-time in-house certified inspectors shall verify "pick count" yarn density in relation to the backing, to ensure the accurate amount of face yarn per square inch.
- E. The manufacturer's full-time, in-house, certified inspectors shall perform turf inspections at all levels of production including during the tufting process and at the final stages before the turf is loaded onto the truck for delivery.
 - 1. The manufacturer shall have its own, in-house laboratory where samples of turf are retained and analyzed, based on standard industry tests, performed by full-time, in-house, certified inspectors.

2.7 EXTRA MATERIALS

- A. General: Provide replacement turf panels for baseball and softball excessive wear areas to include pitching mound and home plate.
- B. Provide a minimum of three sets of replacement turf panels for baseball and softball pitching and home plate areas. Original and replacement turf panels shall be constructed with Velcro edges per manufacturer's recommendations. Minimum size of turf replacement panels shall be per Drawings or as follows:
 - 1. Softball Pitching: 4-feet by 10-feet.
 - 2. Baseball/Softball Home Plate: 16 feet diameter.
 - 3. Baseball/Softball 1st and 3rd bases: 4-feet by 10-feet.

PART 3 - EXECUTION

3.1 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, relative to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.
- B. General: Engage a professional land surveyor to lay out the Work and prepare conformance surveys using accepted surveying practices.
 - 1. Establish benchmarks and control points to set lines and levels as necessary to locate each element of Project.
 - 2. Establish dimensions within tolerance indicated. Do not scale Drawings to obtain required dimensions.
 - 3. Inform installers of lines and levels to which they must comply.
 - 4. Check the location and level of every major element as the Work progresses.
 - 5. Notify Architect when deviations from required lines and level exceed allowable tolerance.

SYNTHETIC TURF SURFACING

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6. Close site surveys with an error closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including grading, fill and topsoil placement, utility slopes, and invert elevations.
- D. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.
 1. Prepare and submit As-Built Survey of field layout showing all horizontal and vertical control including all play features, utilities, drainage structures and drainage lines.

3.2 SYNTHETIC TURF INSTALLATION

- A. Examine substrates, areas, and conditions where playing surface will be installed, with Installer present, for compliance with requirements for conditions affecting performance of installed playing surface.
 1. Verify that substrates for placing playing surface are dry, clean and well-compacted.
 2. Submit and confirm approval of certified field verification surveys for the subgrade and top of drainage aggregate surfaces prior to proceeding with synthetic turf.
 3. Verify that installation of grounds, anchors, recessed frames and covers, electrical and mechanical units of work, utility boxes, and similar items located under playing surface has been completed before installing drainage tile.
 4. Verify that irregularities in substrates will not adversely affect installed playing surface.
 5. Verify ambient temperatures are following manufacturer's recommendations for installation.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.
- C. Over subgrade and filter fabric, install synthetic turf in accordance with manufacturer's written instructions. Seams shall be adhered and sewn with thread specifically made for the turf materials according to manufacturer's recommendations for installation. Glued seams are unacceptable.
- D. Fasten synthetic turf to 1-1/2-inch recessed concrete curb and treated wood nailer board. Install nailer board with stainless steel corrosion-resistant mechanical anchors. Install turf with corrosion-resistant mechanical anchors and adhesive per manufacturer's recommendations.
- E. Vibrate sand infill materials into turf thatch zone at rate and depth per Drawings and as recommended by manufacturer. Infill mix will fill up to 75-percent of the turf pile height minimum to allow for settling.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor shall engage a qualified independent testing agency to perform field quality-control testing.
- B. Testing agency shall inspect and test the following:
 - 1. Surface performance requirements.
 - 2. Surface impact and shock absorbency according to ASTM F 1936 and ASTM F 355.
- C. Proceed with subsequent work only after test results for previously completed work comply with requirements.
- D. When testing agency reports that subgrades have not achieve degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.4 WARRANTY MAINTENANCE

- A. As a condition of the warranty, Contractor shall review the condition of the playing surfaces on a yearly basis for the 8-year warranty period to evaluate Owner's maintenance protocols.
 - 1. Include installation of baseball/softball turf replacement panels at the pitching mound, bases, and home plate as required during the warranty.
- B. Testing Agency: Contractor shall engage a qualified independent testing and inspecting agency to perform tests and inspections at project completion and throughout the duration of the warranty. Unacceptable portions of the field will be rejected and corrected at no additional expense to the Owner. Prepare test reports to ensure satisfactory performance including the following:
 - 1. G_{max} testing for body impacts in accordance with ASTM F355-A Missile. Average at 150 G_{max} or better with no portions of the field exceeding 150 G_{max}.
 - 2. Vertical Deformation for firmness under foot per EN 14809 Vertical Deformation.

3.5 CLEANING AND PROTECTING

- A. Cleaning: Upon completion of installation, clean all playing surfaces so they are free of foreign matter.
- B. Provide final protection and maintain conditions in a manner acceptable to manufacturer and installer that ensure playing surface is without damage or deterioration at the time of Substantial Completion.

END OF SECTION 322201

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Chain-link fences.
 - 2. Baseball/Softball backstops.
 - 3. Guard railing fences.
 - 4. Gates: Swing.
 - 5. Gates: Self-closing and latching with panic hardware.

- B. Related Sections:

- 1. Section 033000 "Cast-in-Place Concrete" for post footings and concrete maintenance strip below fencing.
 - 2. Section 323119 "Decorative Metal Fences and Gates" for manufactured decorative steel fences.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design chain-link fences and gates using performance requirements and design criteria indicated.
- B. Structural Performance: Ballfield backstops and guardrail fencing and framework shall withstand effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7:
 - 1. Minimum Post Size and Maximum Spacing for Wind Velocity Pressure: Determine based on mesh size and pattern specified, and on the specified minimum design wind pressures and according to CLFMI WLG 2445:
 - a. Wind Speed: per ASCE-7(05); 90mph (3 second gust).
 - b. Live loads for Guard Rail Fencing: Up to 50 lbs. per lineal foot along fence top rail per building code.
 - c. Ballfield Backstops: 32-feet (9.75 m)
 - d. Ballfield Fence (with added wind screen fabric by Owner) Height: 8-feet (2.44 m).

- e. Guardrail Fence: 6-feet (2.0 m).
- f. Line Post Group: IA, ASTM F 1043, Schedule 40 steel pipe.
- g. Baseball and Softball Fencing: Include structural design of fence systems at these locations to assume a 100% solid fencing system based on anticipated use of wind screen fabric for wind, snow and ice load calculations.
- h. Wind Exposure Category: C.

1.4 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 chain-link fences and gates.
 - 1. Fence and gate posts, rails, and fittings.
 - 2. Chain-link fabric, reinforcements, and attachments.
 - 3. Gates and hardware.
- B. Shop Drawings: For gates and guardrails include plans, elevations, sections, details, hardware, and panic hardware with special fence infills to prevent unauthorized entry, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.
- C. Samples for Initial Selection: For components with factory-applied color finishes.
- D. Delegated-Design Submittal: For chain-link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional Engineer in the State of Missouri responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of chain-link fence, and gates, from manufacturer.
- B. Product Test Reports: For framing strength according to ASTM F 1043.
- C. Field quality-control reports.
- D. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:
 - 1. Polymer finishes.
 - 2. Gate hardware.
 - 3. Panic hardware.

B. Mockups: Build mockups to set quality standards for fabrication and installation.

1. Include 10-foot (3 m) length of fence and gate which may become part of the completed work once approved.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - b. Fence settling, breakage, connection and material failure.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckled (top and bottom). Comply with CLFMI Product Manual and with requirements indicated below:

1. Fabric Height: As indicated on Drawings.
2. Steel Wire Fabric: Extruded wire for 9-gauge fence fabric.
3. Steel Wire Fence Fabric at Home Plate Backstops (below 8-feet only): Extruded wire for 6 gauge fence fabric on backstops up to 8 feet in height and 9 gauge fence fabric over 8-feet height.
 - a. Mesh Size: 2 inches (50 mm).
 - b. Zinc-Coated Fabric: ASTM A 392, Type II, Class 1, 1.2 oz./sq. ft. (366 g/sq. m) with zinc coating applied after weaving.
 - c. Zn-5-Al-MM Aluminum-Mischmetal-Coated Fabric: ASTM F 1345, Type III, Class 2, 1.0 oz./sq. ft. (305 g/sq. m).

- d. Polymer-Coated Fabric: ASTM F 668, Fused Class 2B over zinc or Zn-5-Al-MM-alloy-coated steel wire.
 - 1) Color: Black, complying with ASTM F 934.
 - e. Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.
4. Selvage: Knuckled at both selvages.

2.2 FENCE FRAMING

- A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:
- 1. Fence Heights: 4-feet, 6-feet, and 8-feet in locations noted on Drawings.
 - 2. Connections: Provide fittings and clamps per manufacturer's recommendations for all fence framing members.
 - 3. Light Industrial Strength: Material Group IC-L, round steel pipe, electric-resistance-welded pipe.
 - a. Line Post: 2.375 inches (60 mm) in diameter.
 - b. End, Corner and Pull Post: 2.875 inches (73 mm).
 - 4. Horizontal Framework Members: Top rail, intermediate and bottom rails on backstop only. Fences 8 feet and less to have top rail and bottom tension wire with corner bracing as required.
 - a. Top Rail: 1.66 inches (42 mm) in diameter.
 - 5. Brace Rails: Comply with ASTM F 1043.
 - 6. Metallic Coating for Steel Framing:
 - a. Type A, consisting of not less than 1.2 oz. per square foot minimum average zinc coating per ASTM A 123/A 123M.
 - b. Polymer-Coating: ASTM F 668, Fused Class 2B over zinc or Zn-5-Al-MM-alloy-coated round steel pipe.

2.3 TENSION WIRE

- A. Polymer-Coated Steel Wire: 0.148-inch- (3.8-mm-) diameter, tension wire complying with ASTM F 1664, Class 2B over zinc or Zn-5-Al-MM-alloy-coated steel wire.
- 1. Color: Black, complying with ASTM F 934.

2.4 SWING GATES

- A. General: Comply with ASTM F 900 for gate posts and single or double swing gate types.
 - 1. Gate Leaf Width: 36 inches (914 mm).
 - 2. Gate Fabric Height: 72 inches (1830 mm) or as noted on Drawings.
- B. Pipe and Tubing:
 - 1. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and PVC finish matching fence framing.
 - 2. Gate Posts: Round tubular steel.
 - 3. Gate Frames and Bracing: Round tubular steel.
- C. Frame Corner Construction: Fencing shall be assembled with corner fittings. Backstop framing shall be welded per manufacturer recommendations.
- D. Hardware:
 - 1. Hinges: Cox-type hinge for 180-degree swing.
 - 2. Latches: Strong-arm type latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
 - 3. Gate Stops: Provide gate stop posts and self-latching device for hold open condition.

2.5 FITTINGS

- A. General: Comply with ASTM F 626.
- B. Post Caps: Provide for each post.
 - 1. Provide line post caps with loop or fitting to receive top rail per Drawings.
- C. Rail and Brace Ends: For each gate, corner, pull, and end post.
- D. Rail Fittings: Provide the following:
 - 1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches (152 mm) long.
- E. Tension and Brace Bands: Pressed steel or aluminum alloy 6063.
- F. Tension Bars: Steel, length not less than 2 inches (50 mm) shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
- G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading or Mill-finished aluminum rod and turnbuckle or other means of adjustment.

- H. Tie Wires, Clips, and Fasteners: Galvanized steel according to ASTM F 626.
 - 1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
 - a. Aluminum: ASTM B 211 (ASTM B 211M); Alloy 1350-H19; 0.148-inch- (3.76-mm-) diameter, mill-finished wire.
- I. Finish:
 - 1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. (366 g/sq. m) zinc.
 - a. Polymer coating over metallic coating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
 - 1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

- A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.
 - 1. Install fence fabric on inside of fence framework on sports field side of fence.
 - 2. Install fencing and concrete maintenance strip 6-inches inside established property line.

3.4 CHAIN-LINK FENCE INSTALLATION

- A. Post Excavation: Drill or hand-excavate holes for posts to footing diameters and spacing indicated, in firm, undisturbed soil.

- B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - a. Top of Fence Footing: Top of footing shall be a minimum of 6 inches below grade to accommodate the concrete mow strip.
- C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 30 degrees or more.
- D. Line Posts: Space line posts uniformly at 10 feet (3 m) o.c.
- E. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
1. Locate horizontal braces at mid-height of fabric 72 inches (1830 mm) or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
- F. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- (3.05-mm-) diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches (610 mm) on center. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
1. Extended along bottom of fence fabric. Install bottom tension wire within 6 inches (152 mm) of bottom of fabric and tie to each post with not less than same diameter and type of wire.
- G. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
- H. Backstop Intermediate and Bottom Rails: Install and secure to posts with fittings as recommended by manufacturer.
- I. Chain-Link Fabric: Apply fabric to inside of enclosing framework. Leave 1-inch (25 mm) between top of maintenance strip and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- J. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches (380 mm) o.c.

- K. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
 - 1. Maximum Spacing: Tie fabric to line posts at 12 inches (300 mm) o.c. and to braces at 24 inches (610 mm) o.c.
- L. Fasteners: Install nuts tight and secure by mechanical means for tension bands and carriage bolts opposite the playing field side of the fence.
- M. Backstops: Provide framework fittings.

3.5 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.6 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 323113

SECTION 323119 - DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Decorative metallic-coated-steel tubular picket fences.
 - 2. Swing gates.
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete"
 - 2. Section 033053 "Miscellaneous Cast-in-Place Concrete" for concrete.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For gates. Include plans, elevations, sections, details, and attachments to other work.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Product Test Reports: For decorative metallic-coated-steel tubular picket fences, including finish, indicating compliance with referenced standards.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Include 10-foot (3-m) length of fence complying with requirements.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 DECORATIVE METALLIC-COATED-STEEL TUBULAR PICKET FENCES

A. Decorative Metallic-Coated-Steel Tubular Picket Fences:

1. Basis-of-design Product: Subject to compliance with requirements, provide Master Halco; Montage Plus or approved equal from the following:
 - a. Ameristar Fence Products.
2. Comply with ASTM F 2408 for light industrial (commercial) application (class) unless otherwise indicated.

B. Posts:

1. End and Corner Posts: Square tubes 3 by 3 inches (76 by 76 mm) formed from 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch (2.66-mm) nominal-thickness steel sheet and hot-dip galvanized after fabrication.
2. Posts at Swing Gate Openings: Square tubes 3 by 3 inches (76 by 76 mm) formed from 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch (2.66-mm) nominal-thickness steel sheet and hot-dip galvanized after fabrication.
3. Posts at Swing Gate Openings: Square steel tubing 3 by 3 inches (76 by 76 mm) with 3/16-inch (4.76-mm) wall thickness, hot-dip galvanized.

C. Post Caps: Aluminum castings.

D. Rails: Square tubes.

1. Size: 1-1/2 by 1-1/2 inches (38 by 38 mm).
2. Metal and Thickness: 0.079-inch (2.01-mm) nominal-thickness, metallic-coated steel sheet or 0.075-inch (1.90-mm) nominal-thickness, uncoated steel sheet, hot-dip galvanized after fabrication.

E. Pickets: Square tubes.

1. Extend pickets beyond top rail as indicated and terminate with galvanized-steel caps.
2. Picket Spacing: 4 inches (101.6 mm) clear, maximum.

F. Fasteners: Manufacturer's standard concealed fastening system equal to "Pro-Fusion". Pickets-to-rails to have a welded connection at every picket.

- G. Fasteners: Manufacturer's standard tamperproof, corrosion-resistant, color-coated fasteners matching fence components.
- H. Metallic-Coated Steel Sheet: Galvanized-steel sheet or aluminum-zinc, alloy-coated steel sheet.
- I. Interior surface of tubes formed from uncoated steel sheet shall be hot-dip zinc coated same as exterior.
- J. Galvanizing: For components indicated to be galvanized and for which galvanized coating is not specified in ASTM F 2408, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.
- K. Finish: Powder coating with E-coat finishing process for corrosion protection.

2.2 SWING GATES

- A. Gate Configuration: As indicated on Drawings.
- B. Gate Frame Height: 72 inches (1830 mm) minimum or per Drawings.
- C. Gate Opening Width: 12-feet double leaf or as shown on Drawings.
- D. Galvanized-Steel Frames and Bracing: Fabricate members from square tubes 1-1/2 by 1-1/2 inches (38 by 38 mm) formed from 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch (2.66-mm) nominal-thickness steel sheet and hot-dip galvanized after fabrication.
- E. Frame Corner Construction: Welded or assembled with corner fittings and 5/16-inch- (7.9-mm) diameter, adjustable truss rods for panels 5 feet (1.52 m) wide or wider.
- F. Additional Rails: Provide as indicated, complying with requirements for fence rails.
- G. Infill: Comply with requirements for adjacent fence.
- H. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.
- I. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet (1.52 m) wide. Provide center gate stops and cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.
 - 1. Latches: Strong-arm type latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
 - 2. Gate Stops: Provide gate stop posts and latches for double leaf gates for hold open condition.
 - 3. Single Gates: Provide self-latching device.
- J. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.

1. Function: 39 - Full surface, triple weight, antifriction bearing.
 2. Material: Wrought steel, forged steel, cast steel, or malleable iron; galvanized.
- K. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 3/4-inch- (19-mm-) diameter, round steel bars, hot-dip galvanized after fabrication. Finish matching gates. Provide galvanized-steel pipe strikes to receive cane bolts in closed position both open and closed positions.
- L. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.
- M. Galvanizing: For items other than hardware that are indicated to be galvanized, hot dip galvanize finish to comply with ASTM A 123/A 123M. For hardware items, hot dip galvanizing to comply with ASTM A 153/A 153M.
- N. Metallic-Coated-Steel Finish: High-performance powder coating.

2.3 STEEL AND IRON

- A. Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Bars (Pickets): Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.
- C. Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
- D. Bar Grating: NAAMM MBG 531.
1. Bars: Hot-rolled steel strip, ASTM A 1011/A 1011M, Commercial Steel, Type B.
 2. Wire Rods: ASTM A 510 (ASTM A 510M).
- E. Castings: Either gray or malleable iron unless otherwise indicated.
1. Gray Iron: ASTM A 48/A 48M, Class 30.
 2. Malleable Iron: ASTM A 47/A 47M.

2.4 COATING MATERIALS

- A. Epoxy Primer for Galvanized Steel: Epoxy primer recommended in writing by topcoat manufacturer. Provide manufacturer's recommended powder coat finish system.

2.5 MISCELLANEOUS MATERIALS

- A. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi (20 MPa), 3-inch (75-mm) slump, and 1-inch (25-mm) maximum aggregate size.

- B. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M and specifically recommended by manufacturer for exterior applications.

2.6 METALLIC-COATED-STEEL FINISHES

- A. Galvanized Finish: Clean welds, mechanical connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.
- B. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a zinc-phosphate conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.
- C. Powder Coating: Immediately after cleaning and pretreating, apply TGIC polyester powder-coat finish, with a minimum dry film thickness of 2 mils (0.05 mm).
 - 1. Color and Gloss: Black semi-gloss finish to match existing and manufacturer's designations.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.
- B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
 - 1. Construction layout and field engineering are specified in Section 017300 "Execution."

3.3 DECORATIVE FENCE INSTALLATION

- A. Install fences according to manufacturer's written instructions.

DECORATIVE METAL FENCES AND GATES

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- B. Install fences by setting posts as indicated and fastening rails and infill panels to posts. Peen threads of bolts after assembly to prevent removal.
- C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches (600 mm) plus 3 inches (75 mm) for each foot (300 mm) or fraction of a foot (300 mm) that fence height exceeds 4 feet (1.2 m).
 - 1. Posts Set in Concrete: Extend post to within 6 inches (150 mm) of specified excavation depth, but not closer than 3 inches (75 mm) to bottom of concrete.

3.4 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

END OF SECTION 323119

SECTION 323223 - SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 GENERAL

- A. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Summary: This Section includes single and multiple depth segmental, gravity retaining walls with soil reinforcement. Refer to Section 312000 "Earthwork" and Section 332630 "Storm Water Drainage." See drawing details for coordination of footing and/or sleeving of guardrails within engineered backfill behind retaining walls.
- C. All work shall be completed in accordance with the Geotechnical Report prepared for this Project. See Section 003132 "Geotechnical Data" and Section 003132A "Geotechnical Report."

1.2 PERFORMANCE REQUIREMENTS

- A. Basis of Design: Design of segmental retaining walls is based on products indicated. If comparable products of other manufacturers are proposed, provide engineering design for proposed products, including comprehensive engineering analysis by a qualified professional engineer in the State of Missouri, using performance requirements and design criteria indicated.
- B. Delegated Design: Design segmental retaining walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Structural Performance: Engineering design shall be based on the following loads and be according to NCMA's "Design Manual for Segmental Retaining Walls."
 - 1. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.
 - 2. Superimposed loads (surcharge) of 250 psf minimum.
- D. Seismic Performance: Engineering design shall be based on the following loads and factors and be according to NCMA's "Segmental Retaining Walls - Seismic Design Manual."
 - 1. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.
 - 2. Superimposed loads (surcharge) indicated on Drawings.
 - 3. Horizontal Peak Ground Acceleration (A) for Project: As indicated on the Drawings.

1.3 REFERENCE DOCUMENTS

- A. American Society for Testing and Materials (ASTM)

1. ASTM C140 Sampling and Testing Concrete Masonry Units
2. ASTM C1372 Specification for Dry-Cast Segmental Retaining Wall Units
3. ASTM D442 Particle Size Analysis of Soils.
4. ASTM D698 Laboratory Compaction Characteristics of Soil – Standard Effort.
5. ASTM D1556 Standard Test Method for Density and Unit Weight of Soil In Place by the Sand Cone Method.
6. ASTM D1557 Laboratory Compaction Characteristics of Soil – Modified Effort.
7. ASTM D2487 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
8. ASTM D2922 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
9. ASTM D3034 Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer pipe and Fittings.
10. ASTM D4318 Liquid Limit, Plastic Limit and Plasticity Index of Soils.
11. ASTM D4475 Horizontal Shear Strength of Pultruded Reinforced Plastic Rods.
12. ASTM D4476 Flexural Properties of Fiber Reinforced Pultruded Plastic Rods.
13. ASTM D4595 Standard Test Method for Tensile Properties of Geotextiles by Wide-Width Strip Method.
14. ASTM D4873 Standard Guide for Identification, Storage and Handling of Geosynthetics.
15. ASTM D5262 Standard Test Method for Evaluating the Unconfined Tension Creep Behavior of Geosynthetics.
16. ASTM D5321 Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
17. ASTM D5818 Standard Practice for Obtaining Samples of Geosynthetics from a Test Section for Assessment of Installation Damage.
18. ASTM D6637 Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Method.
19. ASTM D6638 Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units.
20. ASTM D6706 Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil.
21. ASTM D6916 Standard Test Method for Determining the Shear Strength Between Segmental Concrete Units.

B. National Concrete Masonry Association (NCMA)

1. NCMA SRWU-1 Test Method for Determining Connection Strength of SRW.
2. NCMA SRWU-2 Test Method for Determining Shear Strength of SRW.

1.4 ACTION SUBMITTALS

- A. Product Data: For wall product indicated with photos of wall with applied color stains and sealer products.
- B. Color Stain and Sealer: Submit color stain and sealer materials with record of excellent performance as recommended by the wall manufacturer for the concrete units. Architect to select a minimum of three colors from manufacturer's full range.

- C. Delegated-Design Submittal: For segmental retaining walls 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. Compliance Review: Qualified professional engineer in the State of Kansas responsible for segmental retaining wall design shall review and approve submittals and source and field quality-control reports for compliance of materials and construction with design.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer.
- B. Product Certificates: For segmental retaining wall units and soil reinforcement, from manufacturer.
 - 1. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
 - 2. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for segmental retaining wall units and soil reinforcement.
 - 1. Include test data for freeze-thaw durability of segmental retaining wall units.
 - 2. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
 - 3. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.
- D. Research/Evaluation Reports: For segmental retaining wall units and soil reinforcement.
- E. Preconstruction test reports.
- F. Source quality-control reports.
- G. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects.
 - 1. Build mockup of segmental retaining wall approximately 72 inches long by not less than 36 inches high.

- a. Include typical soil reinforcement.
 - b. Include typical base and cap or finished top construction.
 - c. Include backfill to typical finished grades at both sides of wall.
 - d. Include typical end construction at one end of mockup.
 - e. Include 36-inch return at 1 end of mockup, with typical corner construction.
 - f. Include typical applied concrete stain and sealer finishes.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
3. Review methods and procedures related to segmental retaining walls including, but not limited to, the following:
 - a. Structural load limitations.
 - b. Construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - c. Field quality-control procedures.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.
- B. Store geosynthetics in manufacturer's original packaging with labels intact. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above 160 deg F (71 deg C) or below 32 deg F (0 deg C), and other conditions that might damage them. Verify identification of geosynthetics before using and examine them for defects as material is placed.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Segmental Retaining Wall:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Keystone; Compac III Straight face modular reinforced block units for retaining walls. Units shall be provided with 4-inch thick wall cap.
 2. Concrete Units: ASTM C 1372 – Standard Specifications for Segmental Retaining Wall Units.
 - a. Texture: Provide straight-face finish hard split in the straight face configuration.
 - b. Compressive strength: ≥ 3000 psi (21 MPa).
 - c. Absorption: ≤ 8 % for standard weight aggregates.
 - d. Dimensional tolerances: $\pm 1/8$ inch (3 mm) from nominal unit dimensions not including rough split face.

- e. Unit Size: 8 inches (203 mm) (H) by 18 inches (457 mm) (W) by 12 inches (304 mm) (D) minimum.
 3. Color: Provide manufacturer's blend of 3-colors. Submit colors from full range for Architect approval.
 4. Shape and Texture: Provide units of dimensions that will produce segmental retaining walls and profiles indicated without interfering with other elements of the Work and with textured exposed face. All exposed sides of wall shall be installed with finished appearance.
- B. Constructability Requirements:
1. Vertical setback: 1/8 inch (3 mm) \pm per course (near vertical) or 1 1/8 inch (28 mm) + per course, per the design.
 2. Alignment and grid attachment mechanism - fiberglass pins, two per unit.
 3. Maximum horizontal gap between erected units shall be \leq 1/2 inch (13 mm).
 4. Cap Units: Provide solid cap units of same shape as other units with smooth, as-cast top surfaces without holes or lugs.
 5. Special Units: Provide corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on exposed surfaces matching face.
 6. Soil reinforcement shall be Geogrid, Type PC, or as recommended by wall design Engineer.
- C. Shear and Reinforcement Pin Connectors
1. Shear and reinforcement pin connectors shall be 1/2-inch (12 mm) diameter thermoset isophthalic polyester resin pultruded fiberglass reinforcement rods to provide connection between vertically and horizontally adjacent units and geosynthetic reinforcement, with the following requirements:
 - a. Flexural Strength in accordance with ASTM D4476: 128,000 psi (882 MPa) minimum.
 - b. Short Beam Shear in accordance with ASTM D4475: 6,400 psi (44 MPa) minimum.
 2. Shear and reinforcement pin connectors shall be capable of holding the geogrid in the proper design position during grid pre-tensioning and backfilling.

2.2 BASE LEVELING PAD MATERIAL

- A. Material shall consist of a compacted crushed stone base, sand and gravel or unreinforced concrete, as shown on the construction drawings.

2.3 UNIT DRAINAGE FILL

- A. Unit drainage fill shall consist of clean 1 inch (25 mm) minus crushed stone or crushed gravel meeting the following gradation tested in accordance with ASTM D-422:

Sieve Size	Percent Passing
1 inch (25 mm)	100
3/4-inch (19mm)	75 – 100
No. 4 (4.75 mm)	0 – 10
No. 50 (300 um)	0 - 5

- B. Drainage fill shall be placed within the cores of, between, and behind the units as indicated on the design drawings. Not less than 1.3 cubic foot (0.036 m3), of drainage fill shall be used for each square foot (0.093 m2) of wall face unless otherwise specified.

2.4 INSTALLATION MATERIALS

- A. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.
- B. Leveling Base: Comply with requirements in Section 312000 "Earthwork."
- C. Leveling Course: Lean concrete with a compressive strength of not more than 500 psi (3.4 MPa).
- D. Drainage Fill: Comply with requirements in Section 312000 "Earthwork."
- E. Reinforced-Soil Fill: Comply with requirements in Section 312000 "Earthwork" for satisfactory soils.
- F. Nonreinforced-Soil Fill: Comply with requirements in Section 312000 "Earthwork" for satisfactory soils.
- G. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.
1. Apparent Opening Size: No. 70 to 100 (0.212- to 0.150-mm) sieve, maximum; ASTM D 4751.
 2. Minimum Grab Tensile Strength: 110 lb (49.9 kg); ASTM D 4632.
 3. Minimum Weight: 4 oz./sq. yd. (132 g/sq. m).
- H. Subdrainage Pipe shall be in accordance with Section 332630 "Storm Water Drainage."
- I. Filter Fabric: Geotextile filter fabric shall be a woven monofilament polypropylene geotextile meeting the requirements of GEOTEX 104F as produced by the Propex Operating Company or approved equal. The individual filaments shall be woven into a regular network and calendared such that filaments retain dimensional stability relative to each other. The geotextile is resistant to ultraviolet degradation and to biological and chemical environments normally found in soils. The Minimum Average Roll Values (MARV) shall be according to the test methods and values in the following table.

PROPERTY	TEST METHOD	ENGLISH
ORIGIN OF MATERIALS		
% U.S. Manufactured Inputs		100%
% U.S. Manufactured		100%
MECHANICAL		
Tensile Strength (Grab)	ASTM D-4632	370 x 250 lbs
Elongation	ASTM D-4632	15 x 15%
CBR Puncture	ASTM D-6241	650 lbs
Trapezoidal Tear	ASTM D-4533	100 x 60 lbs
ENDURANCE		
UV Resistance % Retained at 500 hrs	ASTM D-4355	90%
HYDRAULIC		
Apparent Opening Size (AOS)	ASTM D-4751	70 US Std. Sieve
Percent Open Area	CW-02215 MOD	4-6%
Permittivity	ASTM D-4491	0.28 sec ⁻¹
Water Flow Rate	ASTM D-4491	18 gpm/ft ²
ROLL SIZES		6 ft x 300 ft 12 ft x 300 ft

2.5 SOIL REINFORCEMENT

- A. Soil Reinforcement: Geosynthetic reinforcement shall consist of geogrids manufactured for soil reinforcement applications and shall be manufactured from high tenacity polyester yarn or high-density polyethylene. Polyester geogrid shall be made from high tenacity polyester filament yarn with a molecular weight exceeded 25,000 g/m and with a carboxyl end group value less than 30. Polyester geogrid shall be coated with an impregnated PVC coating that resists peeling, cracking and stripping.
1. Geogrid Manufacturers: Subject to compliance with requirements, and as recommended by the wall manufacturer, provide products by one of the following or pre-approved equal:
 - a. Colbond Inc.
 - b. Huesker, Inc.
 - c. Luckenhaus Technical Textiles, Inc.
 - d. Mirafi Construction Products; Ten Cate Nicolon.
 - e. Propex Fabrics Inc.; Civil Engineering Fabrics.
 - f. Strata Systems, Inc.
 - g. Synteen Technical Fabrics, Inc.
 - h. Tenax Corporation; Subsidiary of Tenax Group.
 - i. Tensar Earth Technologies, Inc.
 - j. Versa-Lok Retaining Wall Systems; a division of Kiltie Corporation.
 - k. Webtec, Inc.
 2. Product Type: Molded geogrid made from high-density polyethylene.

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- B. All design of wall soil reinforcement shall be completed by a qualified Professional Engineer and in accordance with Section 003132A "Geotechnical Report" and Section 312000 "Earthwork."

2.6 DRAINAGE PIPE

- A. Drainage pipe shall be perforated or slotted PVC pipe manufactured in accordance with ASTM D3034 or corrugated dual wall Type N-12 HDPE pipe manufactured in accordance with AASHTO M252.

2.7 SOURCE QUALITY CONTROL

- A. Direct manufacturer to test and inspect each roll of soil reinforcement at the factory for minimum average roll values for geosynthetic index property tests, including the following:
 - 1. Weight.
 - 2. Roll size.
 - 3. Grab or single-rib strength.
 - 4. Aperture opening.
 - 5. Rib or yarn size.

PART 3 - EXECUTION

3.1 EXECUTION

- A. Examination: Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of segmental retaining walls.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 RETAINING WALL INSTALLATION

- A. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.
 - 1. Lay units in running bond.
 - 2. Form corners and ends by using special units. At locations where wall steps down, all exposed portions of the wall shall have finished appearance.
- B. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D 698.
 - 1. Leveling Course: Place unreinforced lean concrete over leveling base 1 to 2 inches thick. Compact and screed concrete to a smooth, level surface.

- C. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level. Retaining wall shall be installed below finished grade elevation as indicated in drawings and as recommended by design Engineer.
 - 1. Tamp units into leveling base as necessary to bring tops of units into a level plane.
- D. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.
 - 1. For units with lugs designed to fit into holes in adjacent units, lay units so lugs are accurately aligned with holes, and bedding surfaces are firmly seated on beds of units below.
 - 2. For units with lips at front of units, slide units as far forward as possible for firm contact with lips of units below.
 - 3. For units with lips at bottom rear of units, slide units as far forward as possible for firm contact of lips with units below.
 - 4. For units with pins, install pins and align units.
 - 5. For units with clips, install clips and align units.
- E. Cap Units: Place cap units and secure with cap adhesive.

3.3 FILL PLACEMENT

- A. General: Comply with requirements in Section 312000 "Earthwork," NCMA's "Segmental Retaining Wall Installation Guide," and segmental retaining wall unit manufacturer's written instructions and recommendations of wall design Engineer.
- B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.
- C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall and place and spread fills toward embankment.
 - 1. Use only hand-operated compaction equipment within 48 inches of wall, or one-half of height above bottom of wall, whichever is greater.
 - 2. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D 698.
 - a. In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight according to ASTM D 698.
 - b. In areas where fill height exceeds 15 feet compact reinforced-soil fill that will be more than 15 feet below finished grade to not less than 98 percent maximum dry unit weight according to ASTM D 698.
 - c. In areas where fill height exceeds 30 feet compact reinforced-soil fill that will be more than 30 feet below finished grade to not less than 100 percent maximum dry unit weight according to ASTM D 698.

3. Compact non-reinforced-soil fill to comply with Section 312000 "Earthwork."
- D. Place a layer of drainage fill at least 12 inches wide behind wall to within 12 inches of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.
- E. Wrap drainage fill with filter fabric as indicated, sloped not less than 0.5 percent to drain.
- F. Place impervious fill over top edge of drainage fill layer.
- G. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at base of wall away from wall. Provide uniform slopes that will prevent ponding.
- H. Place soil reinforcement in horizontal joints of retaining wall where indicated and according to soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of 8 inches into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.
 1. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
 2. Place geosynthetics with seams, if any, oriented perpendicular to segmental retaining walls.
 3. Do not dump fill material directly from trucks onto geosynthetics.
 4. Place at least 6 inches of fill over reinforcement before compacting with tracked vehicles or 4 inches before compacting with rubber-tired vehicles.
 5. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.
 6. "Sleeve-It" type fence footing or PVC pipe for guard rail post installation into concrete will be installed such that soil reinforcement is not damaged during guard rail installation.

3.4 CONSTRUCTION TOLERANCES

- A. Variation from Level: For bed-joint lines along walls, do not exceed 1-1/4 inches in 10 feet, 3-inches maximum.
- B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1-1/4 inches in 10 feet.
- C. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 1-1/4 inches in 10 feet.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Comply with requirements in Section 312000 "Earthwork."
 1. In each compacted backfill layer, perform at least 1 field in-place compaction test for each 24 inches of fill depth and each 100 feet or less of segmental retaining wall length.

3.6 ADJUSTING

- A. Remove and replace segmental retaining wall construction of the following descriptions:
 - 1. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if Engineer approves methods and results.
 - 2. Segmental retaining walls that do not match approved Samples.
 - 3. Segmental retaining walls that do not comply with other requirements indicated.
- B. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION 323223

SECTION 328400 - PLANTING IRRIGATION

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. Irrigation system is a delegated design that includes the diagrammatic layout of irrigation piping, zone valves, irrigation heads and other equipment required for a complete operation irrigation system as shown on the Drawings. The irrigation point-of-connection will be located east of the Field House building per the Drawings. Refer to the Civil Drawings showing the deduct irrigation meter and tap. The POC will be located downstream of the deduct meter. Install the backflow preventer, winterization assembly, and booster pump per the Drawings.
- B. Section Includes:
 - 1. Piping.
 - 2. Encasement for piping.
 - 3. Manual valves.
 - 4. Pressure-reducing valves.
 - 5. Automatic control valves.
 - 6. Master control valves.
 - 7. Transition fittings.
 - 8. Dielectric fittings.
 - 9. Miscellaneous piping specialties.
 - 10. Sprinklers.
 - 11. Quick couplers.
 - 12. Flow Sensor.
 - 13. Irrigation controller
 - 14. Two-wire decoders.
 - 15. Boxes for automatic control valves.
 - 16. Backflow Preventer.
 - 17. Booster Pump.

1.3 DEFINITIONS

- A. Circuit Piping: Downstream from control valves to sprinklers. Piping is under pressure during flow.

- B. Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 PERFORMANCE REQUIREMENTS

- A. Irrigation zone control shall be automatic operation with controller and automatic control valves.
- B. Location of Sprinklers and Specialties: The diagrammatic design layout of heads, valves, main line and laterals and all irrigation equipment is approximate. Contractor will provide adjustments as necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent head-to-head irrigation coverage of areas indicated.
- C. Delegated Design: Submit irrigation design plans including comprehensive engineering analysis by a Certified Irrigation Designer (CID) of the Irrigation Association, using performance requirements and design criteria indicated. Provide system design capable of providing a minimum of 1-inch of water per week for lawn areas within a six-hour daily watering window. Assumed watering window between 3am and 7am and 4pm to 6pm. Provide design for system winterization by compressed air. Include the following information at a minimum:
 - 1. Pressure loss calculations to furthest zone.
 - 2. Mainline and lateral pipe sizing.
 - 3. Zoning chart showing multiple valve operation.
 - 4. Booster pump design.
- D. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:
 - 1. Irrigation Main Piping: 200 psig (1380 kPa).
 - 2. Circuit Piping: 200 psig (1380 kPa).
 - 3. Mainline and lateral pipe velocities shall not exceed 5 fps.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For irrigation systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional responsible for their preparation.

- D. Coordination Drawings: Irrigation systems, drawn to scale, on which components are shown and coordinated with each other, using input from Installers of the items involved. Also include adjustments necessary to avoid plantings and obstructions such as signs and light standards.
- E. Qualification Data: For qualified Installer.
- F. Zoning Chart: Show each irrigation zone and its control valve.
- G. Controller Timing Schedule: Indicate timing settings for each automatic controller zone.
- H. Field quality-control reports.
- I. Operation and Maintenance Data: For sprinklers controllers and automatic control valves to include in operation and maintenance manuals.
- J. Project Record (As-Built) Drawings:
 - 1. Record pipe and wiring network alterations. Record accurate reference dimensions, measured from at least two permanent reference points, of each irrigation system valve, sprinkler, each decoder address, each sleeve end, and other irrigation components enclosed within a valve box.
 - 2. Prior to construction completion, transfer the information contained on the project record drawings maintained on site onto the design drawings. Label each sheet "Record Drawing."
 - 3. Submit hard copy record drawings and electronic CAD files to the Architect/Engineer. Electronic files to be provided in an electronic format acceptable to the Architect/Engineer. Submittal of the complete record drawings is a prerequisite for the review at the completion of the irrigation system installation.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers that include a certified irrigation designer qualified by The Irrigation Association.
- B. 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.
- C. American Society for Testing and Materials (ASTM):
 - 1. ASTM D 3350-02 Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.
 - 2. ASTM D 2737-03 Standard Specification for Polyethylene (PE) Plastic Tubing.
 - 3. ASTM F 714-08 Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
 - 4. AWWA C 901 Standard Specification for Pipe Pressure Classification.
 - 5. AWWA C 906 Standard Specification for Pipe Pressure Classification.
 - 6. NSF 61 Standard Specifications for Pipe Agency Listing of Pipes Suitable as a Pressure Conduit.

7. ASTM D 3261-03 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
8. ASTM F 1055-98 Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.
9. ASTM F 2164-02 Standard Practice for Field Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. 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.
- B. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 1. Notify Architect and Owner no fewer than two days in advance of proposed interruption of water service.
 2. Do not proceed with interruption of water service without Owner's written permission.

1.9 TESTING

- A. Notify the Architect and Construction Manager three days in advance of testing.
- B. Pipelines jointed with rubber gaskets or threaded connections may be subjected to a pressure test at any time after partial completion of backfill. Pipelines jointed with solvent-welded PVC joints shall be allowed to cure at least 24 hours before testing.
- C. Subsections of mainline pipe may be tested independently, subject to the review of the Engineer.
- D. Furnish clean, clear water, pumps, labor, fittings, and equipment necessary to conduct tests or retest.
- E. Hydrostatic Pressure Test:
 1. Subject mainline pipe to a hydrostatic pressure equal to the anticipated operating pressure for two hours. Test with mainline components installed.
 2. Subject lateral pipe to a hydrostatic pressure equal to the anticipated operating pressure.
 3. Backfill to prevent pipe from moving under pressure. Expose couplings and fittings.
 4. Leakage will be detected by visual inspection, replace defective pipe, fitting, joint, valve, or appurtenance. Repeat the test until the pipe passes test.

5. Cement or caulking to seal leaks is prohibited.

F. Operational Test:

1. Activate each remote-control valve in sequence from the controller. The Engineer will visually observe operation, water application patterns, and leakage.
2. Replace defective remote-control valve, decoders, solenoids, wiring, or appurtenance to correct operational deficiencies.
3. Replace, adjust, or move water emission devices to correct operational or coverage deficiencies.
4. Replace defective pipe, fitting, joint, valve, sprinkler, or appurtenance to correct leakage problems. Cement or caulking to seal leaks is prohibited.
5. Repeat test(s) until each lateral passes all tests. Repeat tests, replace components, and correct deficiencies at no additional cost to the Owner.

1.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Tools and Spare Parts: Provide the following operating keys, servicing tools, and spare parts.
 1. Two operating keys for each type of manually operated valve.
 2. Two of each servicing wrench or tool needed for complete access, adjustment and repair of all rotary sprinklers.
 3. Two quick coupling keys, each with attached hose swivel ell for operation of the quick coupling valves.
 4. Five of each type of spray sprinkler used.
 5. Five of every spray sprinkler nozzle used.
 6. Five of each type of rotary sprinkler used complete with nozzle.
 7. Two of each size of remote-control valve used.
 8. Other Materials: Provide other materials or equipment shown on the Drawings or installation details that are part of the irrigation system, even though such items may not have been referenced in these specifications.

1.11 GUARANTEE/WARRANTY AND REPLACEMENT

- A. For a period of one year from commencement of the formal maintenance period, guarantee/warranty irrigation materials, equipment, and workmanship against defects. Fill and repair depressions. Restore landscape or structural features damaged by the settlement of irrigation trenches or excavations. Repair damage to the premises caused by a defective item. Make repairs within seven days of notification from the Engineer.
- B. Guarantee/warranty applies to originally installed materials and equipment and replacements made during the guarantee/warranty period.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Comply with requirements in the piping schedule for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.
- B. Laterals, PVC Pipe, Pressure Rated: ASTM D 2241, PVC 1120 compound, Class 200 SDR 21 rated at 200 psi.
 - 1. PVC Socket Fittings: ASTM D 2466, Schedule 40, Type 1, PVC solvent weld fittings.
 - 2. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket or threaded ends.
- C. Specialized Pipe and Fittings:
 - 1. Where necessary use the following connections:
 - a. Copper Pipe: Use Type K rigid conforming to ASTM Standard B88. Use wrought copper or cast bronze fittings, soldered or threaded per the installation details. Use 95% tin and 5% antimony solder.
 - b. Ductile Iron Pipe: Use Class 50 conforming to ANSI A21.51 (AWWA C151). Use a minimum of Class 53 thickness pipe for flanged piping. Use mechanical joints conforming to ANSI A 21.10 (AWWA C110) and ANSI A21.11 (AWWA C111) or flanged fittings conforming to ANSI/AWWA C110 and ANSI B16.1 (125#).
 - c. Use a dielectric union wherever a copper-based metal (copper, brass, and bronze) is joined to an iron-based metal (iron, galvanized steel, and stainless steel).
 - d. Low Density Polyethylene Hose:
 - 1) Use pipe specifically intended for use as a flexible swing joint.
 - 2) Inside Diameter: 0.490 ± 0.010 inch.
 - 3) Wall Thickness: 0.100 ± 0.010 inch.
 - 4) Color: Black.
 - 2. Use spiral barb fittings supplied by the same manufacturer as the hose.
 - 3. Assemblies calling for threaded pipe connections shall utilize PVC Schedule 80 nipples and PVC Schedule 40 threaded fittings.
 - 4. Joint sealant: Use only Teflon-type tape or Teflon based paste pipe joint sealant on plastic threads. Use non-hardening, nontoxic pipe joint sealant formulated for use on water-carrying pipes on metal threaded connections.
- D. Thrust Blocks:
 - 1. Use thrust blocks for fittings on pipe greater than or equal to 3-inch diameter or any diameter rubber gasketed pipe.
 - 2. Use 3,000 psi concrete.
 - 3. Use 2 mil plastic.

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4. Use No. 4 rebar wrapped or painted with asphalt tar based mastic coating.
5. Thrust blocks will be installed at all tees, bends, reducer fittings and ends of gasket joint pipelines. Thrust blocks will be poured in forming concrete material, placed between undisturbed soil and the fitting to be thrust blocked. No other blocking method will be allowed without consent of the irrigation consultant.
6. The size of the thrust block is determined by the working pressure, size and type of fitting, and the soil conditions at the job site. To calculate the area of contact with soil, follow these steps:
 - a. Calculate the total thrust by selecting thrust/100 by size and type of fitting from Table 1 and multiplying thrust/100 by system pressure divided by 100. Divide the total thrust by the bearing capacity of the soil in excavation (from Table 2) to determine the area (sq. ft.) of thrust block required to be in contact with the undisturbed soil. Example 2-inch Tee in Soft Clay: $363 \times 120 \text{ psi}/100 = 435.6/1000 = 0.44 \text{ sq. ft.}$ in contact with undisturbed soil.

TABLE 1 – THRUST/100 TABLE (POUNDS PER 100 PSI)				
SIZE	TEE, PLUGS	90 BENDS	45 BENDS	22.5 BENDS
2 inch	363	513	259	141
2.5 inch	531	751	379	207
3 inch	788	1114	562	307
4 inch	1302	1841	928	508
6 inch	2822	3990	2012	1101
8 inch	4783	6763	3410	1865
10 inch	7430	10506	5297	2898
12 inch	10452	14778	7452	4076

- b. For reducers, subtract small opening plug thrust from large opening plug thrust to calculate thrust/100.

TABLE 2- SOIL BEARING CAPACITY	
SOIL TYPE	SAFE BEARING LOAD LBS. PER SQ. FT.
Soft Clay	1000
Sand	2000
Sand and Gravel	3000
Sand and Gravel Cement with Clay	4000
Hard Pan	10000

- c. The Engineer assumes no responsibility for the above bearing load data. The Contractor is responsible determining safe bearing loads and when doubt exists, soil bearing tests should be specified. The bearing loads given are for horizontal thrust when depth of cover exceeds 2 ft.

E. Joint Restraint Harness:

1. Use joint restraints harness wherever joints are not positively restrained by flanged fittings, threaded fittings, and/or thrust blocks.
2. Use a joint restraint harness with transition fittings between metal and PVC pipe, where weak trench banks do not allow the use of thrust blocks, or where extra support is required to retain a fitting or joint.
3. Use bolts, nuts, retaining clamps, all-thread, or other joint restraint harness materials, which are zinc plated or galvanized.
4. Use on all push-on gate valves 3 inches and larger.

F. Mainline Pipe Materials (2-Inches and Larger):

1. High Density Polyethylene Pipe: All pipe and tubing is free of blisters, internal striations, cracks, or any other defects or imperfections. The pipe and tubing are continuously and permanently marked with manufacturer's name, material type, size and schedule or class and quality control identifications.
 - a. Qualifications of Pipe Manufacturer: HDPE pipe shall be manufactured in a plant capable of providing continuous quality control through inspection. The facility shall have the necessary testing equipment to verify that the pipe meets the requirements of AWWA C 901 or C 906, NSF Standards, and ASTM Standards.
 - b. Qualifications of the Fittings Manufacturer: The facility shall have the necessary testing equipment to verify that the fittings meet requirements of AWWA C 901 and C 906 and ASTM Standards.
 - c. Materials: Polyethylene pipe and fittings shall be made from resin meeting the requirements of the Plastic Pipe Institute as PE4710. The resin shall meet the requirements of ASTM D 3350-02 with a cell classification of 345464C. The pipe shall have a manufacturing standard of ASTM D 2737 and ASTM F 714. The pipe shall be DR 17 (125 psi WPR) unless otherwise specified on the Drawings. The pipe shall contain no recycled compounds except those generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipes shall be suitable for use as pressure conduits, and per AWWA C 901 and C906 and have normal burst values of three times the Working Pressure Rating (WPR) of the pipe. Pipe shall also have the following agency listing of NSF 61.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. JM Eagle.
 - b. Lamson Pipe Company.
 - c. Performance Pipe.
 - d. PolyPipe, Inc.

G. Mainline HDPE Fittings:

1. Butt Fusion Fittings: Fittings shall be PE 3408 HDPE, cell classification 345464C as determined by ASTM D 3350-02 and approved for AWWA use. Butt fusion fittings

shall have a manufacturing standard of ASTM D 3261. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified on the Drawings. All fittings shall be suitable for use as pressure conduits and per AWWA C 901 and C 906. All fittings shall have a normal burst value of 3-1/2 times the Working Pressure Rating (WPR) of the fitting.

2. Electrofusion Fittings: Fittings shall be PE 3408 HDPE, cell classification 345464C as determined by ASTM D 3350-02 and approved for AWWA use. Electrofusion fittings shall have a manufacturing standard of ASTM F 1055. All electrofusion fittings shall have a pressure rating equal to the pipe unless otherwise specified on the Drawings. All fittings shall be suitable for use as pressure conduits and per AWWA C 901 and C 906. All fittings shall have a normal burst value of 3-1/2 times the Working Pressure Rating (WPR) of the fitting.
3. Flanged and Mechanical Joint Adapters: Flanged and mechanical joint adapters shall be PE 3408 HDPE cell classification 345464C as determined by ASTM D 3350-02. Fittings shall have a manufacturing standard of ASTM D 3261. All fittings shall have a normal burst value of 3-1/2 times the Working Pressure Rating (WPR) of the fitting.
4. Interchangeability of Pipe and Fittings: HDPE pipe and fittings can be supplied by different manufacturers if they meet the ASTM D 3350-02 cell classification.
5. Pipe Manufacturer's Quality Control: The pipe manufacturer shall have an ongoing Quality Control program for incoming and outgoing materials. HDPE resins for manufacturing shall be checked for density, melt flow rate and contamination. The manufacturer of the HDPE resin shall certify the cell classification as indicated in this Section. These incoming resins shall be approved by the Plant Quality Control and verified to be approved by NSF before being converted to pipe.
 - a. Pipe shall be checked for outside diameter, wall thickness, length, roundness and surface finish on the inside, outside and end cut.
6. Fittings Manufacturer's Quality Control: The fitting manufacturer shall have an ongoing Quality Control program for incoming and outgoing materials. The resin shall be checked as indicated in this Section. Pipe for fabricated fittings shall be checked as indicated previously in this Section. Molded fittings shall be inspected for voids and knit lines. All fabricated fittings shall be inspected for joint quality and alignment.

H. HDPE Mainline Joining Methods and Materials:

1. Butt Fusion Joining:
 - a. Plain end pipe and fittings shall be made using butt fusion. The butt fusion procedures shall be in accordance with the manufacturer or PPI (Plastic Pipe Institute). The fusion equipment operator shall receive training using the recommended procedure. The Contractor shall be responsible to verify that the fusion equipment is in good operating condition and that the operator has been trained within the past twelve months. Fusion beads shall not be removed.
 - b. Training: The supplier of the pipe and fittings shall provide a person certified by the pipe manufacturer and/or fusion equipment manufacturer to train contractor fusion equipment operators and inspectors representing the Owner.
2. Electrofusion Coupling Joining:

- a. Polyethylene pipe and fittings may be joined using approved electrofusion couplings. The electrofusion procedures shall be in accordance with the manufacturer or PPI (Plastic Piping Institute). The electrofusion equipment operator shall receive training using the recommended procedure. The Contractor shall be responsible to verify that the electrofusion equipment is in good operating condition and that the operator has been trained within the past twelve months.
3. Training: The supplier of the pipe and fittings shall provide a person certified by the pipe manufacturer and/or electrofusion equipment manufacturer to train contractor electrofusion equipment operators and inspectors representing the Owner.

2.2 PIPING JOINING MATERIALS

- A. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.3 ENCASEMENT FOR PIPING

- A. Pressure Rated PVC Pipe: ASTM D 2241, PVC 1120 compound, Class 200 SDR 21.
- B. PVC Socket Fittings: ASTM D 2466, Schedule 40 PVC, Type I, PVC solvent weld fittings.

2.4 Brass Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. DynaQuip Controls.
 - d. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
 - e. Hammond Valve.
 - f. Jamesbury; a subsidiary of Metso Automation.
 - g. Jomar International, LTD.
 - h. KITZ Corporation.
 - i. Legend Valve.
 - j. Marwin Valve; a division of Richards Industries.
 - k. Milwaukee Valve Company.
 - l. NIBCO INC.
 - m. Red-White Valve Corporation.
 - n. RuB Inc.
2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).

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- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Two piece.
- e. Body Material: Forged brass.
- f. Ends: Threaded or solder joint if indicated.
- g. Seats: PTFE or TFE.
- h. Stem: Brass.
- i. Ball: Chrome-plated brass.
- j. Port: Full or regular, but not reduced.

2.5 AUTOMATIC CONTROL VALVES

A. Plastic, Automatic Control Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Rainbird; PGA Plastic Industrial Valve, or comparable product by one of the following:
 - a. Buckner; a division of Storm Manufacturing Group Inc.
 - b. Champion Irrigation Products.
 - c. Dig Corporation.
 - d. Hunter Industries Incorporated.
 - e. Irritrol Systems.
 - f. Nelson, L. R. Corporation.
 - g. Rain Bird Corporation.
 - h. Superior Controls Co., Inc.
 - i. Toro Company (The); Irrigation Division.
 - j. Weathermatic.
2. Description: Durable glass-filled nylon body, globe-type, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac solenoid.

2.6 MASTER CONTROL/ISOLATION VALVES

A. Brass, Automatic Control Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Rainbird; GB-R Brass Industrial Control Valve, or comparable product by one of the following:
 - a. Hunter Industries Incorporated.
 - b. Nelson, L. R. Corporation.
 - c. Rain Bird Corporation.
 - d. Superior Controls Co., Inc.
 - e. Toro Company (The); Irrigation Division.
2. Description: Durable fabric reinforced diaphragm, globe-type, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac solenoid.

2.7 TRANSITION FITTINGS

- A. General Requirements: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
- B. Transition Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cascade Waterworks Manufacturing.
 - b. Dresser, Inc.; DMD Division.
 - c. Ford Meter Box Company, Inc. (The).
 - d. JCM Industries.
 - e. Smith-Blair, Inc; a Sensus company.
 - f. Viking Johnson.
 - 2. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.
- C. Plastic-to-Metal Transition Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Harvel Plastics, Inc.
 - b. Spears Manufacturing Company.
 - 2. Description: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-socket or threaded end.

2.8 MISCELLANEOUS PIPING SPECIALTIES

- A. Pressure Gages: ASME B40.1. Include 4-1/2-inch- (115-mm-) diameter dial, dial range of two times system operating pressure, and bottom outlet.

2.9 SPRINKLERS

- A. General Requirements: Designed for uniform coverage over entire spray area indicated at available water pressure.
- B. Plastic, Pop-up, Gear-Drive Rotary Sprinklers:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Hunter Industries Incorporated.

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- b. Rain Bird Corporation.
 - c. Toro Company (The); Irrigation Division.
- 2. Description:
 - a. Body Material: ABS.
 - b. Nozzle: Brass reinforced nozzle turret, ABS nozzle.
 - c. Retraction Spring: Stainless steel.
 - d. Internal Parts: Corrosion resistant.
- 3. Capacities and Characteristics:
 - a. Flow: 1.6 to 12 GPM flow at 45 PSI. Provide matched precipitation nozzles.
 - b. Pop-up Height: Minimum 5 inches (31 mm) aboveground to nozzle.
 - c. Arc: Fully adjustable circle with arc memory capability.
 - d. Radius: 30 to 50 feet.
 - e. Inlet: NPS 3/4 (DN 20).
 - f. Built-in check valve device.

C. Plastic, Pop-up Spray Sprinklers:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Hunter Industries Incorporated.
 - b. Rain Bird Corporation.
 - c. Toro Company (The); Irrigation Division.
- 2. Description:
 - a. Body Material: ABS.
 - b. Nozzle: ABS.
 - c. Retraction Spring: Stainless steel.
 - d. Internal Parts: Corrosion resistant.
 - e. Pattern: Fixed or adjustable, with flow adjustment.
 - f. Built-in check valve.
 - g. Pressure regulating stem to regulate incoming pressure.
- 3. Capacities and Characteristics:
 - a. Nozzle: ABS.
 - b. Flow: 0.5 to 3.7 GPM.
 - c. Pop-up Height: 6 inches (lawn) and 12 inches (shrub beds (15,2 cm to 30,4 cm) aboveground to nozzle.
 - d. Arc/Pattern: Full, Half, Quarter, Strip, and adjustable circle/pattern.
 - e. Radius: 8 to 15 feet (2,4 to 4,7 m).
 - f. Inlet: NPS 1/2 (DN 15).

2.10 QUICK COUPLERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Rainbird; Model 44-DRC or comparable product by one of the following:
1. Champion Irrigation Products.
 2. Hunter Industries Incorporated.
 3. Toro Company (The); Irrigation Division.
- B. Description: Factory-fabricated, bronze or brass, 1-inch, (25-mm) two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap; hose swivel with ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet; and operating key.
1. Locking-Top Option: Vandal-resistant locking feature. Include two matching key(s).

2.11 CONTROLLERS

- A. Basis-of-Design Products: Subject to compliance with requirements, provide Rainbird; ESP-LXD Two-Wire Decoder Controller with flow management and ET-based irrigation management software module for PC compatibility, including required FD-Turf Two-Wire Sensor Field Decoders, line surge protection. Provide Rainbird PBC-LXD program back-up cartridge. Provide compatible Rainbird Wireless Rain/Freeze Sensor Model WR2-RFC and connections to controller. Comparable products by one of the following manufacturers are acceptable:
1. Hunter Industries Incorporated.
 2. Superior Controls Co., Inc.
 3. Toro Company (The); Irrigation Division.
- B. Description:
1. Provide Rainbird 24 VAC Tyco Relay (K10P-11A15-24) and a field decoder (FD102TURF). Install equipment and controller in a lockable enclosure with two matching keys.
 2. 50-Station plus expansion capability.
 3. Exterior Control Enclosures: NEMA 250, Type 4, weatherproof, with locking cover and two matching keys. Include provision for grounding.
 - a. Body Material: Plastic, weather resistant and lockable enclosure.
 - b. Mounting: Wall mount type.
 4. Control Transformer: 24-V secondary, with primary fuse.
 5. Timing Device: 11-program capability (10 irrigation plus one non-irrigation program) with simultaneous operation and up to six start times per program.

- a. Surge Protection: Provide Rainbird MSP-1 Surge Protection and MGP-1 Grounding Plate for each controller or weather station as recommended by the manufacturer.
6. Flow Sensors and Transmitters: Provide impeller-type, PVC flow sensor with flow transmitter at points on mainline to isolate each field or irrigation area.
7. Control Wire:
 - a. Verification of wire types and installation procedures shall be checked by the Contractor to conform to local and state codes.
 - b. Maxi #14/2 communication wire. Conductor construction shall be tin coated, soft drawn bare copper meeting the requirements of ASTM Specification B-33. The two conductors shall be insulated with a high quality polyvinylchloride (PVC) for system applications up to 600 volts. One conductor shall be insulated black and the other conductor shall be red. Both conductors shall be of the same size as specified and/or shown on the Drawings and as required for the proper operation of the decoder units connected to it. The two conductors shall be laid parallel and pressure extruded with a solid color, linear low density, sunlight-resistant polyethylene (PE) outer jacket as manufactured by Regency Wire. Colors shall be manufacturer's standard red, green, blue, yellow, black, purple and orange.
 - c. Wire color shall be continuous over its entire length. Each leg shall be a separate color.
 - d. Splices: Use 3M DBY or DBR splices.

2.12 BOXES FOR AUTOMATIC CONTROL VALVES

A. Plastic Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. Nationwide Plastics, Inc.
 - d. NewBasis.
 - e. Oldcastle, Inc.
 - f. Orbit Irrigation Products, Inc.
 - g. Rainbird Corporation, Inc.
 - h. US Filter/Plymouth Products, Inc.
2. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade.
 - a. Size: As required for valves and service.
 - b. Shape: Round Rectangular.
 - c. Sidewall Material: PE.
 - d. Cover Material: PE.

1) Lettering: "IRRIGATION".

- B. Drainage Backfill: Cleaned gravel or crushed stone, graded from 3/4-inch (19 mm) minimum to 3 inches (75 mm) maximum.

2.13 BACKFLOW PREVENTER

- A. Double Check Backflow Preventer: Install in valve box. Refer to Drawings for Backflow Preventer. Comply with local jurisdiction for equipment and installation.

2.14 BOOSTER PUMPS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Watertronics Model "WMBV-5000Q-2-10-280-3-110" or approved equal by one of the following:

1. Grundfos.
2. Rainbird.

- B. Description: A prefabricated, self-contained, enclosed variable speed (VFD) 5-horsepower horizontal centrifugal pump station with piping, valves, enclosure and base painted, color to be Dark Green. Controls shall be an operator interface with software programming written specifically for this project. A formed and reinforced base platform and enclosure with locking lid containing all manifolding, pumps, motors, and control panels (disconnect mounted externally) to provide an integral unit ready for installation, anchored to a concrete pad.

- C. Standard controls and equipment shall include the following:

1. External mounted NEMA 4 service rated main disconnect panel.
2. UL Listed control panel.
3. Alarm conditions with safety shutdown including low discharge pressure shutdown, high discharge pressure shutdown, VFD fault shutdown and high pump temperature shutdown.
4. Overload, single phase, phase imbalance/low voltage protection.
5. Surge protection for main station and solid-state controls.
6. Variable frequency drive pressure regulation.
7. Pressure start.
8. Hand/off/auto selector switch.
9. Stainless steel pressure transducer.
10. Motor: 5 Hp, 3600 RPM horizontal centrifugal pump and ODP motor. Pump to be cast iron with a bronze impeller and mechanical seal.
11. Silicone filled pressure gauges with isolation valve on suction and discharge piping.
12. Station discharge isolation valve.
13. Force fan air cooled ventilated 14-gauge steel pump station enclosure and steel base painted with locking access cover.
14. Baked and cured two-part polyurethane ultraviolet insensitive paint.
15. Factory certified dynamic run testing of pump station up to full flow and pressure prior to shipment.
16. Operator and maintenance manual.

17. One-year limited warranty on mechanical and electrical components.
18. Access to customer service technical phone support, technicians on call 24/7.
19. Access to factory authorized service technician.

D. Capacities and Characteristics: Manufacturer shall confirm and provide the following specific pump characteristics based on performance requirements shown on the irrigation Drawings.

1. Station Performance: Assume 60 PSI dynamic inlet pressure with 110 GPM flow at the outlet with a 50 PSI minimum boost. Field verify existing inlet pressure.
2. Discharge Head: 110 PSI minimum.
3. Discharge Size: 3-inch NPS (75 mm).
4. Speed: Per manufacturer.
5. Motor Horsepower: To be confirmed by manufacturer.
6. Pressure Rating: 60 psig (4.1 bars).
7. Volts: 280v.
8. Phases: Three phases.
9. Hertz: 60 Hertz.
10. Full-load Amperes: Per manufacturer.
11. Minimum Circuit Ampacity: Per manufacturer.

E. Maximum Overcurrent Protection: Per manufacturer.

2.15 MOTORS

A. General requirements for motors are specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size shall be 480-volt, 3-phase, large enough so that driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earthwork."
- B. Install warning tape directly above pressure piping, 12 inches (300 mm) below finished grades, except 6 inches (150 mm) below subgrade under pavement and slabs.
- C. Provide minimum cover over top of underground piping according to the following:
 1. Irrigation Main Piping: Minimum depth of 24 inches (600 mm) below finished grade, or not less than 18 inches (450 mm) below average local frost depth, whichever is deeper.
 2. Circuit Piping: 12 inches (300 mm).

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3. Sleeves: 24 inches (600 mm).

3.2 PREPARATION

- A. Set stakes to identify locations of proposed irrigation system. Obtain Architect's approval before excavation.

3.3 EXCAVATION, TRENCHING, AND BACKFILLING

A. Backfill:

1. The backfill of all trenches shall be done in a minimum of three steps. The initial backfill shall not extend more than eight inches above the pipe and or wiring. After suitable compaction, additional backfill shall be layered and compacted in layers no more than twelve inches in depth. Powered mechanical compaction equipment shall be used as necessary to prevent future settling. A powered mechanical pole tamper shall be carefully used around sprinklers and valve boxes to prevent future settling.
2. The backfill shall be thoroughly compacted and evened off with the adjacent soil level, except as modified by any plan requirement to replace sod or planting bed materials. Selected fill dirt or sand shall be used if soil conditions are as discussed above. The fill dirt or sand shall be used in filling four inches above the pipe. The remainder of the backfill shall contain no lumps of rocks larger than three inches. The top six inches of backfill shall be free of rocks over one inch, subsoil or trash. Open trenches or partially backfilled trenches shall be kept to a minimum and effort shall be made to completely backfill all trenches opened each day.
3. The Contractor will be responsible for restoration of all settlement for a period of one year from acceptance. All settling of trenches greater than one inch shall be sufficient for the Contractor to refill and re-compact as required. The timing and response for any refill or re-compaction shall be at the sole discretion of the Owner. Excavate to permit the pipes to be laid at the intended elevations and to permit work space for installing connections and fittings.

B. Minimum Cover (Distance from Top of Pipe or Control Wire to Finish Grade):

1. 24-inch over mainline pipe equal to and smaller than 4-inch.
2. 30-inch over mainline pipe equal to and larger than 6-inch.
3. 18-inch over mainline pipe less than 3-inch.
4. 18-inch over control wire.
5. 12-inch over lateral pipe to pop-up spray sprinklers.
6. 18-inch over lateral pipe in Sports Fields.

C. Maintain at least 15-feet clearance from the mainline and laterals to the centerline of any tree.

D. PVC lateral pipes may be pulled into the soil utilizing a vibratory plow device specifically manufactured for pipe pulling. Minimum burial depth equals minimum cover listed above.

E. Backfill only after lines have been reviewed and tested.

- F. Excavated material is generally satisfactory for backfill. Backfill shall be free from rubbish,
- G. Enclose pipe and wiring beneath roadways, walks, curbs, etc., in sleeves. Minimum compaction of backfill for sleeves shall be 95% Standard Proctor Density, ASTM D698-78. Use of water for compaction around sleeves, puddling, will not be permitted.
- H. Dress backfilled areas to original grade. Incorporate excess backfill into existing site grades.
- I. Where utilities conflict with irrigation trenching and pipe work, contact the Engineer for trench depth adjustments.

3.4 PIPING INSTALLATION

- A. Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings.
- B. Install piping free of sags and bends.
- C. Install groups of pipes parallel to each other, spaced to permit valve servicing.
- D. Install fittings for changes in direction and branch connections.
- E. Install unions adjacent to valves and to final connections to other components with NPS 2 (DN 50) or smaller pipe connection.
- F. Install flanges adjacent to valves and to final connections to other components with NPS 2-1/2 (DN 65) or larger pipe connection.
- G. Install underground thermoplastic piping according to ASTM D 2774.
- H. Install expansion loops in control-valve boxes for plastic piping.
- I. Lay piping on solid subbase, uniformly sloped without humps or depressions.
- J. Install concrete thrust blocks at all angles or bends in main line.
- K. Install PVC piping in dry weather when temperature is above 40 deg F (5 deg C). Allow joints to cure at least 24 hours at temperatures above 40 deg F (5 deg C) before testing.
- L. Install water regulators with shutoff valve and strainer on inlet and pressure gage on outlet. Install shutoff valve on outlet. Install aboveground or in control-valve boxes.
- M. Install piping in sleeves under parking lots, roadways, and sidewalks.
- N. Install sleeves made of Class 200 SDR-21 PVC pipe and socket fittings, and solvent-cemented joints.
- O. Install transition fittings for plastic-to-metal pipe connections according to the following:

1. Underground Piping:
 - a. NPS 1-1/2 (DN 40) and Smaller: Plastic-to-metal transition fittings.
 - b. NPS 2 (DN 50) and Larger: AWWA transition couplings.

3.5 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. PVC Pressure Piping: Join schedule number, ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
- D. Thrust Blocks:
 1. Use cast-in-place concrete bearing against undisturbed soil for PVC mainline pipe.
 2. Size, orientation, and placement per accepted standards.
 3. Wrap fittings with plastic to protect joint and fitting from concrete.
 4. Install rebar with mastic coating.

3.6 VALVE INSTALLATION

- A. Remote Control Valve (RCV) Assembly for Sprinkler Laterals:
 1. Flush mainline before installation of RCV assembly.
 2. Wire connectors and waterproof sealant shall be used to connect control wires to remote control valve wires. Install connectors and sealant per the manufacturer's recommendations.
 3. Install only one RCV to a valve box. Locate valve box at least 12 inches from and align with nearby walls or edges of paved areas. Group RCV assemblies together where practical. Arrange grouped valve boxes in rectangular patterns. Allow at least 12 inches between valve boxes.
 4. Adjust RCV to regulate the downstream operating pressure.

3.7 SPRINKLER INSTALLATION

- A. Install sprinklers after hydrostatic test is completed.

- B. Install sprinklers at manufacturer's recommended heights.
- C. Locate part-circle sprinklers to maintain a minimum distance of 6 inches (150 mm) from walls and 3 inches (75 mm) from other boundaries unless otherwise indicated.
- D. Flush lateral before installing sprinkler assembly.
- E. Install sprinklers perpendicular to finish grade.
- F. Supply appropriate nozzle or adjust arc of coverage of each sprinkler for best performance.
- G. Adjust radius of throw of each sprinkler for best performance.

3.8 DECODER SYSTEM INSTALLATION

A. Wiring:

- 1. All wire splices made on the communication wire shall be performed with a King Industries splicing tool. No other tool may be used for splicing. Do not nick or cut the communication wire while splicing. Do not cut into the inner sleeve. All wire splices shall be made with an excess of 18 inches minimum. At no place in the system shall wire be tight.
- 2. 3M DBY's may be used when splicing two communication wires together. Use 3M DBR's when splicing 3 or more wires.
- 3. Communication wire splices not at valves or valve-in-head sprinklers must be placed in a 10-inch round valve box and looped with a minimum of 18 inches excess in order to prevent stretching and to ease in troubleshooting. Locations and direction must be noted accurately on as-built drawings.

B. Decoder Components:

- 1. Install Rainbird FD-101-Turf as required per irrigation delegated design. Clearly mark decoder address on valve box and as-built drawings. Use 3M DBY or DBR waterproof connectors with a minimum of 18 inches excess at all locations.
- 2. Install Rainbird MSP-1 Surge Protector, or approved equal, as required. Each MSP-1 shall be installed in a 10-inch round valve box and to a minimum of 10 ohms or less. If necessary to achieve 10 ohms or less, add supplemental grounding. Test each MSP-1 approximately 4 weeks after installation. Clearly mark locations on the as-built drawings.

C. Testing of the Decoder System:

- 1. Before final acceptance, perform a system current check. No more than ten percent over current reading will be accepted. Each FD-101 decoder draws 0.5 milliamps. If the system fails this test, Contractor is responsible to locate and repair the fault or faults immediately before final acceptance.

3.9 CONNECTIONS

- A. Comply with requirements for piping specified in Division 22 Section "Facility Water Distribution Piping" for water supply from exterior water service piping, water meters, protective enclosures, and backflow preventers. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 1. Connect piping between booster pump and water piping.
- B. Install piping adjacent to equipment, valves, and devices to allow service and maintenance.
- C. Connect wiring between controllers and automatic control valves.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.10 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on each automatic controller.
 - 1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
 - 2. Include As-Built diagrammatic plan inside controller showing location of all irrigation zones, valves, piping and irrigation equipment.
- C. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tapes over underground piping during backfilling of trenches. See Section 312000 "Earthwork" for warning tapes.

3.11 FIELD QUALITY CONTROL

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

1. Leak Test: After installation of mainline, charge system and hold 80 psi for at least 2 hours with less than 2 lbs. of pressure loss, and check for leaks. Repair leaks and retest until no leaks exist.
 2. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Any irrigation product will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.12 WINTERIZATION AND SPRING STARTUP

- A. Perform first year winterization service in the fall and start up the irrigation system in the spring.
1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Verify that controllers are installed and connected according to the Contract Documents.
 3. Verify that electrical wiring installation complies with manufacturer's submittal.
 4. Repair any damage caused due to improper winterization or construction.
- B. Conduct winterization and startup in the presence of the Owner's maintenance personnel. Provide 48 hours' notice to Owner of these activities.

3.13 ADJUSTING

- A. Adjust settings of controllers.
- B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.
- C. Adjust sprinklers and devices so they will be flush with, or not more than 1/2 inch (13 mm) above, finish grade.

3.14 CLEANING

- A. Flush dirt and debris from piping before installing sprinklers and other devices.

3.15 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain the flow sensor for leak detection, automatic control valves and system control equipment.

LEE'S SUMMIT MIDDLE SCHOOL #4
PACKAGE 3 – BUILDING & SITE
LEE'S SUMMIT, MISSOURI

13-20102-00
8 OCTOBER 2020
PERMIT SET

END OF SECTION 328400

PLANTING IRRIGATION

328400 - 24

SECTION 329010 - NATURAL TURF PLAYING FIELD

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. Natural turf athletic fields include placement of root zone mix, sand cap, laser grading, and providing all finish athletic field surfaces.
- B. Earthwork Requirements:
 - 1. Excavation, trenching, grading, filling, backfilling, compaction.
 - 2. Disposal of spoil materials.
- C. Playing Field Requirements:
 - 1. Root zone mix and sand cap layer and amendments.
 - 2. Sand layer cap.
 - 3. Pitching mound and home plate.
 - 4. Infield and Warning Track
 - 5. Turf sod.
- D. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Section 328400 "Planting Irrigation."
 - 2. Section 329010 "Soil Preparation."
 - 3. Section 329200 "Turf and Grasses."
 - 4. Section 334100 "Storm Utility Drainage Piping".

1.3 DEFINITIONS

- A. Excavation: Removal of material encountered to sub grade elevations indicated and subsequent disposal or placement of materials removed.
 - 1. Existing subgrade is designed to be graded to ± 0.1 foot to allow for fine grading of subgrade for the playing field and allows placement of a 6-inch minimum topsoil depth.
- B. Unauthorized Excavation: Inadvertent or purposely removing materials beyond indicated subgrade elevations or dimensions without specific direction of Construction Manager.

1. Unauthorized excavation, as well as remedial work resulting from unauthorized excavation directed by Construction Manager shall be at Contractor's expense.
 2. Unauthorized excavation, including disposition of additional excavated materials and other work resulting from slides, cave-ins or remedial work shall be at Contractor's expense.
- C. Subgrade: The undisturbed earth or the compacted soil layer immediately below proposed drainage fill or playing field soil materials.
- D. Unclassified Excavation: The term "unclassified excavation", as used herein, includes the excavation of all materials required for the work obtained within construction limits of project, including bedrock, surface boulders, wasted sections of concrete, asphalt or other debris.

1.4 SUBMITTALS

- A. Agronomic Materials Testing: Provide an agronomic topsoil analysis and recommendations for soil amendments. Amend topsoil per Division 32 Section "Turf and Grasses."
- B. Contractor Qualifications: Contractor shall have successfully constructed five (5) or more baseball, softball, or similar sports fields over the past eight (8) years and have been in use successfully for over three or more years. The Contractor must have been responsible for the sports field layout, laser grading, and installation of infield and outfield materials, irrigation systems, and field drainage/sub-drainage systems. Contractor will provide a list of sports field references including names and contact information for at least five projects completed in the last eight years.
- C. Contractor Certifications: Contractor's superintendent or staff responsible for constructing the athletic fields shall have the following certifications:
1. Contractor/Installer shall be certified and a member in good standing with American Sports Builders Association (ASBA). Submit certification documents.
 2. Certified Sports Field Manager (CSFM) as designated by Sports Turf Managers Association (STMA).
- D. Field Conformance Survey: Submit certified survey by professional Surveyor of the topographic surface of the completed field surfaces at 25-feet on center each way, before turf sod is installed, to confirm finish grade of playing field meets positive slope requirements of the Drawings. If the field does not meet slope requirements, corrections need to be made and conformance survey repeated until field meets slope requirements.
- E. Test Reports: The following reports shall be submitted directly to the Construction Manager from the testing services, with copy to the Contractor:
1. Field reports are specified in Part 3, Field Quality Control Article.
- F. Material Certifications: Manufacturer's or vendor's certified analysis for baseball infield and warning track areas, soil amendments, fertilizers, turf sod, and over-seed mix.

1. Supplier List: Submit list of procured and contracted suppliers of all soil materials required for the natural turf field no later than 21 days after notice to proceed.
 - a. Contacts and phone numbers shall be included in verification.

1.5 QUALITY ASSURANCE

- A. Codes and Standards: Comply with all applicable local, state and Federal rules, regulations and ordinances concerning sloping of excavation, trenching and safety of workers, including the latest version of OSHA requirements.
- B. Sports Field Construction: Comply with latest edition of NFHS Court and Field Diagram Guide.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer.
 1. Protect materials from deterioration during delivery and while stored at site.
- B. Topsoil Mix: Utilize stockpiled topsoil material on site or imported topsoil as required if quantities are insufficient as subgrade or adjacent to athletic fields to meet finish grades per Drawings. Coordinate with the Construction Manager and place soil materials in an area free of contamination.
- C. Sod: All sod shall be transported to site and placed with twenty-four (24) hours after cutting.
 1. Sod cutting and shipping shall be coordinated with the sod installers.

1.7 MAINTENANCE

- A. General: Playing field contractor to perform maintenance activities necessary to maintain the Natural Turf Playing Field sixty (60) days from the date of Substantial Completion.
- B. Minimum Requirements: The following list of items represents the minimum operations necessary to maintain the fields during the installation period.
 1. Maintenance items shall include, but not be limited to the following:
 - a. Mowing: Turf shall be maintained to a neat uniform appearance using only reel-type, clean, sharp, non-contaminated equipment.
 - 1) Turf shall be maintained to a height of 3/4 inch to 1 inch during initial and substantial completion.
 - 2) Remove grass clippings only when an unsightly condition will occur.

- 3) Frequency will be dependent on the removal of no more than 1/3 of the blade height at any one time to maintain the desired turf height.
 - 4) Mowing patterns shall vary with each cut.
- b. Rolling: The turf field shall be rolled in two directions on initial planting of the sod.
- 1) Care shall be taken not to damage irrigation heads.
 - 2) Additional rolling shall be accompanied by additional aerification operations.
 - 3) One and one-half to two-ton rollers, maximum.
- c. Top Dressing: In addition to the initial top dressing during the sod installation to fill in gaps between sod, two lifts of 1/4 inch are required, using a commercially blended mix of 80% washed sand and 20% of course peat moss.
- 1) Additional top dressing as required to insure a smooth and safe playing surface may be required.
 - 2) Care shall be used to avoid smothering sod.
 - 3) One top dressing shall occur prior to both initial completion and substantial completion.
 - 4) Aerification: Aeration of the field shall be required at least one time prior to playing on the field and only after the sod is firmly knitted.
 - a) Removal of cores is required.
 - b) Only hallow the line equipment shall be utilized with a maximum of 1/2-inch diameter with 3-inch x 3-inch grids.
- d. Fertilization: Four days after sod installation, apply "Launch", or approved equal, liquefied fertilizer by spray at 4 ounces per 1,000 square feet or as recommended by manufacturer.
- 1) Apply two applications minimum during maintenance period.
 - 2) One week after the installation of the sod and the initial fertilization, apply 1/2 pound of N of Scott's Product 8420 (9-0-32) or equivalent per 1,000 sq. ft. every five to seven days until root zone surface is stabilized and turf clippings can be collected.
 - a) An appropriate fertilizer and rate shall be applied as recommended by the fertility tests throughout Substantial Completion.
 - b) Both granular and liquid fertilizers can be used.
- e. Weed and Pest Control:
- 1) All treatments will comply with local and state codes.
 - 2) Utilize only commercially licensed personnel and applicators to perform these operations.
 - 3) Treatments shall be made according to the needs of the field as determined by the Owner.

- f. Irrigation System: The system shall be adjusted on a continual basis as necessary to maintain specified coverage.
 - 1) Head shall be adjusted to elevation when necessary.
 - 2) All repairs to lines, valves, and heads.
 - 3) Field mixes shall be performed in a timely manner repairing to the previous condition and specifications.
 - 4) Heads shall be cleaned as necessary to insure full pop-up and flush lowered positions.
- g. Controller: Controller shall be set for appropriate watering intervals with adequate instructions to the maintenance staff.
- h. Irrigation Record Drawings:
 - 1) Indicate actual location of all valves and controls including piping.
 - 2) Show dimensions from easily identifiable existing features such as walls, fences, steps, etc.

PART 2 - PRODUCTS

2.1 NATURAL ATHLETIC FIELD SOIL MATERIALS

- A. General: All fill material, regardless of intended use category, shall be clean and free from organic matter, roots, brush or other vegetation, trash, debris or other detrimental substances, and rocks or unbroken lumps larger than 3 inches, and shall be tested and approved by the soil testing and inspection agency prior to placement.
 - 1. Trench Backfill: Existing soils obtained from Playing Field excavations, excluding broken and pulverized weathered bedrock.
 - 2. Unacceptable Soil Materials: Existing on-site material or asphalt materials not suitable for fill.
- B. Root Zone Mix: Root zone mix to consist of a commercially blended 80-percent loamy topsoil with 20-percent clean, washed USGA sand. Install at a 6-inch minimum depth below all sodded areas on athletic fields.
- C. Sand Cap: Sand to be a washed uniform sand meeting USGA requirements for sieve analysis.
- D. Infield Area: Provide a commercially blended infield soil mix with 60-percent sand, 20-percent silt, and 20-percent clay. Install at a 3-inch minimum depth in all skinned infield areas, compact and laser grade as required. Install "Turface" or commercially available calcined clay for infield use. Provide product by DuraEdge or Southern Athletic Fields at a 0.25 to 0.50-inch depth. Install about 400 pounds per 1,000-square feet of infield area.
- E. Warning Track: Install a 3-inch minimum depth of a commercially blended infield soil mix with 60-percent sand, 20-percent silt, and 20-percent clay in all warning track areas, compact and laser grade as required for positive drainage over the fencing concrete mow strip. Top with a

blended crushed aggregate of Turface SAF Trac Select or approved equal. Aggregate to have ¾-inch minus well-graded particles. Install at a 1-inch thickness.

- F. Mound, Home Plate, and Bullpen Areas: Commercially available Pro Mound Packing Clay by Advanced Turf Solutions, or approved equal.

2.2 SOD AND GRASS MATERIALS

- A. Sod: Tall Turf-Type Fescue sod blend with 10 percent Bluegrass, non-netted or approved equal for installation on all Athletic Fields.
- B. Sod shall be 9-10 months old with minimal thatch, well groomed and fertilized.

PART 3 - EXECUTION

3.1 EXAMINATION AND PROTECTION

- A. Verification of Conditions: Examine areas and conditions under which all work of this Section is being performed.
 - 1. Do not proceed with any work until unsatisfactory conditions have been corrected.
 - 2. Commencement of work implies acceptance of all areas and conditions.
- B. Protection of Work: Protect all on-going work so as not to delay work due to weather or project related construction.
 - 1. This includes but is not limited to the use of tarps, geo-textile, plywood and other protective measures.
- C. Protection of Adjacent Construction: Protect adjacent construction throughout the entire operation.
 - 1. Protect newly graded areas from destruction by weather or runoff.
 - 2. Protect structures, utilities, pavements, and other improvements from damage caused by settlement, lateral movement, undermining and washout.
- D. Unanticipated Conditions: Notify the Architect immediately upon finding evidence of previous structures, filled materials, which penetrate below designated excavation levels, or other conditions which are not shown, or which cannot be reasonably assumed from existing surfaces and Geotechnical reports.

3.2 EARTHWORK EXECUTION

- A. General: Remove material of every nature or description encountered in obtaining required lines and grades. Excavate and/or place and compact fill to provide for elevation(s) required by Drawings.
 - 1. Excavation is all considered unclassified and includes excavation to subgrade elevations indicated regardless of character of materials and obstructions encountered.
 - 2. Conform to elevations and grades shown within a tolerance of $\pm \frac{1}{2}$ -inch in 25 ft. in either direction.
- B. Irrigation System Trenching: Make trenches for main and laterals straight and true with the bottoms graded on uniform slopes to low points.
 - 1. Excavate trenches wide enough to allow a minimum of 4 inches between parallel pipelines; 8 inches from lines of other trades.
 - 2. Do not install lines parallel and directly over one another.
 - 3. Maintain 2-inch vertical clearance between irrigation lines; minimum transverse angle is 45 degrees. A maximum of 2 lines per trench.
- C. Pipeline Trenches: Trenches for pipelines shall be made of sufficient depths to provide the minimum cover from finished grade as follows:
 - 1. 18 inches over main lines and quick coupling valves.
 - 2. 12 inches over RCV controlled lines (lateral).

3.3 PLACEMENT AND COMPACTION OF SOIL MATERIALS

- A. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills.
 - 1. When existing subgrade ground surface has a density of less than that specified under "Compaction" for particular areas classification, break up ground surface.
 - 2. Scarify existing subgrade to depth of 8 inches prior to compacting.
 - 3. Moisture condition between 3 percent below and 2 percent above optimum moisture content, and re-compact to at least 95 percent of standard proctor density (ASTM D 698).
- B. Backfill for Irrigation Lines: Sand free backfill material for mainline pipe is to be tamped in 4-inch layers under the pipe and uniformly on both side of the full width of the trench or as shown, and the full length of the pipe.
 - 1. PVC pipe shall not rest on concrete, rock, wood blocks, or similar items.
 - 2. All irrigation pipe shall be immediately backfilled with preliminary backfill sufficient to prevent arching or slipping under pressure.
- C. Other than for preliminary backfill, do not allow or cause any of the Work to be covered before it has been inspected, tested by the Contractor and approved by the Architect.

- D. Before compaction of subgrade, moisten or aerate each layer as necessary to provide optimum moisture content.
 - 1. Compact each layer to required percentage of maximum dry density or relative dry density.
 - 2. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- E. Failing: If, based on the testing and inspection agency reports and inspections, compacted subgrade or fills are found to be below specified density, provide additional compaction and testing in accordance with specifications.
- F. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations.
 - 1. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.
 - a. Subgrade Ground Surface and Bottom of Trench Compaction Requirements: Compact soil to not less than 95% of standard Proctor density, with a moisture condition between 3% below and 2% above optimum moisture content in accordance with ASTM D 698.
 - b. Moisture Control: Where subgrade soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.
 - c. Limit weight of all vehicles on fields to a maximum of 7 lbs/sq. in. with use of floatation type tires.
 - d. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

3.4 IRRIGATION PIPING AND HEAD INSTALLATION

- A. General: Plastic pipe and fittings shall be solvent welded using solvents and methods as recommended by manufacturer or the pipe, except where screwed connections are required. Pipe and fittings shall be thoroughly cleaned of dirt, dust and moisture before applying solvent with a non-synthetic bristle brush.
 - 1. Pipe may be assembled and welded on the surface. Snake pipe from side to side of trench bottom to allow for expansion and contraction.
 - 2. Connections between plastic pipe and metal valves shall be made using plastic male adapters and applying the recommended threaded joint compound.
 - 3. All metal screwed joints shall be tightened with tongs or wrenches and employ the specified joint compound. Caulking of any kind will not be permitted.

- B. Closing: Cap or plug openings in lateral and main lines leaving caps and plugs in place until removal is necessary for completion of installation. Take other precautions as necessary to prevent dirt and debris from entering pipe or equipment.
- C. Flushing: Lines shall be thoroughly flushed out before installing quick coupling valves, sprinklers or emitters.
 - 1. After flushing, main line pipe may be partially backfilled, butt joint, fittings and connections shall remain free and visible.
- D. Nozzle Patterns: Nozzle patterns are indicated and shown on the Drawings; however, specific site conditions may require that different nozzle patterns be used. Contract shall adjust patterns to provide adequate coverage.
 - 1. Adjustment: Adjust alignment and coverage of all heads. If it is determined that adjustments in the irrigation equipment will provide proper and more adequate coverage, make all necessary changes or make arrangements with the manufacturer to have adjustments made, prior to any planting. These changes or adjustments shall be made without additional cost.
- E. Valve Boxes: Locate boxes immediately adjacent to turf field outside of running track or in foul territory, not on sports field area, matching finish grade.
- F. Sports Field Rotor Sprinklers: Install sprinklers on 1-inch pre-manufactured Schedule 40 PVC swing joint. Install head flush with finish grade of turf sod.
- G. Purging and Testing: Immediately prior to hydrostatic testing, all irrigation lines shall be thoroughly purged of all entrapped air. Introduce water into lines to be tested at full operating head pressure. Observe water flow at end of discharge point until determination is made that all air and residual debris has been expelled from the line. Conduct hydrostatic testing followed by completing the piping assembly and adjust sprinkler heads for proper distribution.

3.5 IRRIGATION CONTROLLER INSTALLATION

- A. Electrical Control Wires: Installed in the same trench as the main line wherever possible, wires shall be laid alongside the pipe by snaking into the trench to allow as much slack as possible for contraction and expansion of the wire. All wire connections at remote control valves and at all wire splices shall be left with two feet of wire so that the splice or the valve manifold can be brought to the surface for repairs without disconnecting the wires.
 - 1. Joint shall be waterproof to prevent leakage of water and corrosion build-up on the connection. All wiring shall be accomplished with as few splices as possible.

3.6 PLAYING FIELD SOIL MATERIAL INSTALLATION

- A. Root Zone Soil Mix:

1. Apply the topsoil mixture over the scarified Subgrade and irrigation systems to a 6-inch minimum depth and fine grade surface using laser-guided grading equipment according to finish grades and slopes indicated on the Drawings.
 - a. Material shall be installed in a workable condition.
 - b. Rootzone soil mix shall be installed within ½- inch in 25 feet either direction ± of elevation shown on Drawings when compacted except where shown flush to adjoining conditions per the Drawings.
 - c. Contractor shall move the topsoil mix from the stockpile in such a manner that contaminated materials are not tracked onto the field from the tracks or tires.
 - d. If determined by the Owner or Owner's Representative that contamination is occurring, on-site samples will be taken and tested at the expense of the Contractor. Any contamination or over compacted conditions will require immediate action by the Contractor to satisfy the intent of the specifications.
 - e. Install 2-inch sand cap material over rootzone mix.
 - f. Use vehicles with turf-rated tires to avoid compaction of rootzone mix.
2. Compaction of root zone soil mix: Operate the irrigation system and thoroughly flood the field.
 - a. Fill allow spots to finish grade with root zone mix and water in. This process shall be repeated as required to bring the field to finish grade specifications and tolerance forming a smooth firm surface.
 - b. Finish grades and material depths shall be verified utilizing laser operated survey instruments.
 - c. If roller is used to obtain field grade, surface shall be scarified prior to sodding.
 - d. Field compaction shall not exceed bulk density as performed in laboratory testing.
 - e. Conduct playing field conformance survey for review and approval prior to turf sod installation.

B. Sand Cap:

1. Install USGA sand cap over root zone mix

3.7 SOD AND GRASS INSTALLATION

- A. Pre-Sodding Fertilization: Immediately prior to sodding and after compaction of the root zone mix is complete, incorporate into the upper 1 to 2 inches of the root zone mix a fertilizer with the following ratios:

AMOUNT IN POUNDS	FERTILIZER RATIO
3.8	N (40% soluble, 60% slow release)
6.5	P205
6.5	K20

1. Micronutrient package to include 3.4 pounds of Scott's Step per 1,000 sq. ft. or equivalent.
 - a. Verify types and ratio with Testing Agent prior to application.
- B. Laying Sod: The entire area shall be approved by the Owner's Representative and the Owner prior to laying sod.
 1. Areas to receive sod shall be firm and the irrigation and drainage system shall be operational.
 2. Lay sod within 24 hours from time of stripping.
 3. Sod not placed within 24 hours will be rejected.
 4. Lay sod to form a solid mass with tightly fitted joints.
 - a. Overlap all ends and trim to butt tight.
 - b. Butt sides of sod strips; do not overlap.
 - c. Stagger strips to offset joints in adjacent courses.
 - d. Work from boards when necessary to avoid damage to subgrade.
 - e. Tamp or roll lightly to ensure contact with subgrade.
 5. Top Dress Field:
 - a. After laying and rolling of sod, fill joints and seams with approved topdressing mixture.
 - b. Broom or sweep excess material to avoid smothering turf.
 - c. Thoroughly walk all seams to verify that all have been filled.

3.8 IRRIGATION OF SOD AND GRASS

- A. General: Begin irrigation as sod is completed in anyone section and water to a depth of four inches below the new sod pad.
 1. After a short drying period, roll the sod area in two directions to ensure contact with soil mixture and to smooth the area.
 2. Water sod areas, as required, through Substantial Completion and until Owner takes possession.
 3. Adjust irrigation heads as required for spray pattern and depth to finish grade.

3.9 FIELD QUALITY CONTROL

- A. Quality Control During Construction: Allow testing service to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.
 1. Irrigation Lines Trenching: Perform one field density and moisture test for every 200 sq. ft. or major fraction thereof, of trench backfill, taken at the bottom of pipe elevation and at 18-inches vertical interval in the compacted fill depth.

- a. In no case will less than eight tests be made.
 - b. Where underground utility lines penetrate foundations, perform field density tests at the bottom of pipe elevation and at every two feet of vertical rise in compacted fill elevation at points two feet and ten feet in horizontal distance from the foundation wall.
2. Failings: If, based on the testing and inspection agency reports and inspections, compacted subgrade or fills are found to be below specified density, provide additional compaction and testing in accordance with specifications.
3. Acceptance of Sod: At the end of each day, the Owner's Representative shall observe in place sod for conformance with requirements.
 - a. Unacceptable sod shall be removed immediately from the site and replaced the following work day.
 - b. This preliminary acceptance does not guarantee final acceptance at Substantial Completion.
- B. Sod Root Depth: Sod shall display a minimum average of roots 3-1/2 inch in depth prior to acceptance of field at Substantial Completion.

3.10 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. Removal from Owner's Property: Remove waste materials, including materials not allowed for fill, backfill or site grading as specified within, trash, and debris, and dispose of it off Owner's property at Contractor's expense.

END OF SECTION 329010

SECTION 329113 - SOIL PREPARATION

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 and athletic field soils specified by composition of the mixes.
- B. Related Requirements:
 - 1. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
 - 2. Section 329010 "Natural Turf Playing Field" for athletic field rootzone mix.
 - 3. Section 329200 "Turf and Grasses" for placing planting soil mix for turf and grasses.
 - 4. Section 329300 "Plants" for placing planting soil for plantings.

1.3 DEFINITIONS

- A. AAPFCO: Association of American Plant Food Control Officials.
- B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended, or unamended soils 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.

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. Laboratories: Subject to compliance with requirements, provide testing by the following:
 - a. Turf Diagnostics and Design; 613 East 1st Street; Linwood KS 66052; telephone 913-723-3700; fax 913-723-3701; contact Sam Ferro.

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 soils.
 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 Contractor in presence of Architect or state-certified, -licensed, or -registered soil scientist under the direction of the testing agency.

1. Number and Location of Samples: Minimum of three representative soil samples from varied locations for onsite stockpiled topsoil and for each soil to be used or amended for athletic fields, lawn areas, and landscape planting 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.
2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D698 (Standard Proctor).

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 NCR-13, 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. Manganese-availability ppm.
 10. Zinc ppm.
 11. Zinc availability ppm.
 12. Copper ppm.
 13. Sodium ppm and sodium absorption ratio.
 14. Soluble-salts ppm.
 15. 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.
 16. 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. (100 sq. m) for 6-inch (150-mm) depth 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. (100 sq. m) for 6-inch (150-mm) depth 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 BY COMPOSITION

- A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.
- B. Planting-Soil Type for Lawns and Grasses and Planting areas: Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce viable planting soil. Blend existing, on-site surface soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
 1. Ratio of Loose Compost to Soil: 1:4 by volume.
 2. Weight of Lime: Determined by agronomic soils report in pounds per 1000 sq. ft. (100 sq. m) per 6-inches (150 mm) of soil depth.
 3. Weight of Iron Sulfate: Determined by agronomic soils report in pounds per per 1000 sq. ft. (100 sq. m) per 6 inches (150 mm) of soil depth.
 4. Weight of Agricultural Gypsum: Determined by agronomic soils report in pounds per per 1000 sq. ft. (100 sq. m) per 6 inches (150 mm) of soil depth.
 5. Weight of Commercial Fertilizer: Determined by agronomic soils report in pounds per 1000 sq. ft. (100 sq. m) per 6 inches (150 mm) of soil depth.
 6. Weight of Slow-Release Fertilizer: Determined by agronomic soils report in pounds per 1000 sq. ft. (100 sq. m) per 6 inches (150 mm) of soil depth.
- C. Planting-Soil Type for Athletic Fields: Manufactured soil consisting of manufacturer's basic sandy loam according to USDA textures, blended in a manufacturing facility with sand, stabilized organic soil amendments, and other materials to produce viable planting soil.
 1. Additional Properties of Manufacturer's Basic Soil before Amending: Soil reaction of pH 6 to 7 and minimum of 6 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
 2. Unacceptable Properties: Manufactured soil shall not contain 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 5 percent by dry weight of the manufactured soil.
 - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 1-inches (25 mm) in any dimension.
- 3. Blend manufacturer's basic soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
 - a. Ratio of Loose Compost to Soil: 1:4 by volume.
 - b. Ratio of Loose Sphagnum Peat to Soil: 1:4 by volume.
 - c. Volume of Sand: 80 -percent of root zone mix mix by volume.
 - d. Weight of Lime: Determined by agronomic soils report in pounds per cu. yd. (cu. m).
 - e. Weight of Iron Sulfate: Determined by agronomic soils report in pounds per cu. yd. (cu. m).
 - f. Weight of Agricultural Gypsum: Determined by agronomic soils report in pounds per cu. yd. (cu. m).
 - g. Weight of Superphosphate: Determined by agronomic soils report in pounds pe per cu. yd. (cu. m).
 - h. Weight of Commercial Fertilizer: <Insert weight> per [cu. yd. (cu. m)] <Insert value>.
 - i. Weight of Slow-Release Fertilizer: <Insert weight> per [cu. yd. (cu. m)] <Insert value>.

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 (2.36-mm) sieve and a minimum of 75 percent passing through a No. 60 (0.25-mm) sieve.
 - 2. Class: O, with a minimum of 95 percent passing through a No. 8 (2.36-mm) sieve and a minimum of 55 percent passing through a No. 60 (0.25-mm) sieve.
 - 3. Form: Provide lime in form of ground [dolomitic limestone] [calcitic limestone] [mollusk shells] <Insert material>.
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through a No. 40 (0.425-mm) sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Perlite: Horticultural perlite, soil amendment grade.
- E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 (0.30-mm) sieve.

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- F. Sand: Clean, Coarse, washed, natural or manufactured, free of toxic materials, and according to ASTM C33/C33M.. Sand to be a washed uniform sand meeting USGA requirements for sieve analysis

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: 50 to 60 percent of dry weight.
 - 6. Particle Size: Minimum of 98 percent passing through a 1-inch (25-mm) sieve.
- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a 1/2-inch (13-mm) sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of maximum 5 dS/m.

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: 1 lb/1000 sq. ft. (0.5 kg/100 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
 - 2. 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: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
 - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified 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 (150 mm) 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 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 (50-mm) 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 (100 mm). Remove stones larger than 1-1/2 inches (38 mm) 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 (50 mm) of subgrade. Spread remainder of planting soil.
- C. Mixing: Spread unamended soil to total depth of 6 inches (150 mm), 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.

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- a. Mix lime and sulfur with dry soil before mixing fertilizer.
 - b. Mix fertilizer with planting soil no more than seven days before planting.
2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches (200 mm) in loose depth for material compacted by compaction equipment, and not more than 6 inches (150 mm) in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698 and tested in-place.
- 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 MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply manufactured soil on-site in its final, blended condition. 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 (100 mm). Remove stones larger than 2 inches (50 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
1. Apply approximately half the thickness of planting soil over prepared, loosened subgrade. Mix thoroughly into top 2 inches (50 mm) of subgrade. Spread remainder of planting soil.
- C. Application: Spread planting soil to total depth of 6 inches (150 mm), but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
1. Lifts: Apply planting soil in lifts not exceeding 8 inches (200 mm) in loose depth for material compacted by compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698.
- 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.

3.5 BLENDING PLANTING SOIL IN PLACE

- A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

- B. Preparation: Till unamended, existing soil in planting areas to a minimum depth of 6 inches (150 mm). Remove stones larger than 2 inches (50 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Apply soil amendments, except compost, and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.
 - 1. Mix lime and sulfur with dry soil before mixing fertilizer.
 - 2. Mix fertilizer with planting soil no more than seven days before planting.
- D. Compaction: Compact blended planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698.
- 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.

3.6 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

- A. Application: Apply compost component of planting-soil mix 2-inches (50 mm) of compost to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
 - 1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D698. Space tests at no less than one for each 2000 sq. ft. (200 sq. m) of in-place soil or part thereof.
- 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.

3.8 PROTECTION

- A. 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.
- B. If planting soil or subgrade is over-compacted, 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.

3.9 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 329113

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. Sodding.
 - 3. Hydro-mulching.
 - 4. Erosion-control material(s).

- B. Related Sections:

- 1. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
 - 2. Section 312000 "Earthwork" for excavation, filling and backfilling, and rough grading.
 - 3. Section 328400 "Planting Irrigation" for turf irrigation.
 - 4. Section 329300 "Plants" for border edgings.

1.3 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

- F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- H. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.
- I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.
- 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 sod. Include identification of source and name and telephone number of the supplier.
- C. Qualification Data: For qualified landscape Installer.
- D. Product Certificates: For soil amendments and fertilizers, from manufacturer.
- E. Material Test Reports: For existing native surface topsoil and imported or manufactured topsoil.
- F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf and meadows during a calendar year. Submit before expiration of required initial maintenance periods.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment from seed.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.

2. Experience: Five years' experience in turf installation in addition to requirements in Division 01 Section "Quality Requirements."
 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 4. Personnel Certifications: Installer's field supervisor shall have certification in all of the following categories from the Professional Landcare Network:
 - a. Certified Landscape Technician - Exterior, with installation maintenance irrigation specialty area(s), designated CLT-Exterior.
 - b. Certified Turfgrass Professional, designated CTP.
 - c. Certified Turfgrass Professional of Cool and Warm Season Lawns, designated CTP-CSL.
 5. Maintenance Proximity: Not more than three hours' normal travel time from Installer's place of business to Project site.
 6. Pesticide Applicator: State licensed, commercial.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.
1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
 2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
 3. Report suitability of tested soil for turf growth.
 - a. Based on the test results, state recommendations for soil treatments and rate and amounts of soil amendments to be incorporated into the soil. State recommendations in weight per 1000 sq. ft. (92.9 sq. m) or volume per cu. yd. (0.76 cu. m) for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
- D. Pre-installation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.
- C. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.7 PROJECT CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Spring Planting: March 15th to May 15th.
 - 2. Fall Planting: August 15th to October 30th.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.8 MAINTENANCE SERVICE

- A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:
 - 1. Seeded Turf: 60 days from date of Substantial Completion.
 - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

2. Sodded Turf: 60 days from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species: State-certified seed of grass species as follows:
- C. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
 1. Tall Turf-Type Fescue blend; drought tolerant varieties performing well in local NTEP trials, including:
 - a. 80 percent Tall Turf-Type Fescue (*Festuca arundinacea*).
 - b. 10 percent Kentucky Bluegrass (*Poa pratensis*).
 - c. 10 percent annual Ryegrass (*Lolium multiflorum*).

2.2 TURFGRASS SOD

- A. Turfgrass Sod: Certified, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.
- B. Sod Netting: Netted sod will not be accepted. If sod is delivered to the site with netting, Contractor shall remove the netting and properly dispose of prior to installation of turf sod.
- C. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
 1. Sports Fields and Site Areas: Tall turf type fescue blend, a minimum of three cultivars selected for drought tolerance and having performed well in local NTEP turf trials, including:
 - a. 80 percent tall turf type Fescue blend (*Festuca arundinacea*).
 - b. 10 percent Kentucky bluegrass 'Touchdown' (*Poa pratensis*).

2.3 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, 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 No. 8 (2.36-mm) sieve and a minimum of 75 percent passing through No. 60 (0.25-mm) sieve.
- B. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- C. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 (0.30-mm) sieve.
- D. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

2.4 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 1. Organic Matter Content: 50 to 60 percent of dry weight.
 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- B. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.5 FERTILIZERS

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 10 percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 1. Composition: 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.6 PLANTING SOILS

- A. Planting Soil: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
1. Supplement with another specified planting soil when quantities are insufficient.
 2. Mix existing, native surface topsoil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
 - a. Mix Ratio of Loose Compost to Topsoil by Volume: Blend 4-parts topsoil to 1-part coarse compost.
 - b. Weight of Lime per 1000 Sq. Ft. (92.9 Sq. m): Per soils analysis.
 - c. Weight of Iron Sulfate per 1000 Sq. Ft. (92.9 Sq. m): Per soils analysis.
 - d. Weight of Agricultural Gypsum per 1000 Sq. Ft. (92.9 Sq. m): Per soils analysis.
 - e. Weight of Bonemeal per 1000 Sq. Ft. (92.9 Sq. m): Per soils analysis.
 - f. Weight of Superphosphate per 1000 Sq. Ft. (92.9 Sq. m): Per soils analysis.
 - g. Weight of Commercial Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): Per soils analysis.
- B. Planting Soil: Imported topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from agricultural land, bogs or marshes.
1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch (25 mm) or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, 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 harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.
 2. Mix imported topsoil or manufactured topsoil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
 - a. Ratio of Loose Compost to Topsoil by Volume: Blend 4-parts topsoil to 1-part coarse compost.
 - b. Weight of Lime per 1000 Sq. Ft. (92.9 Sq. m): Per soils analysis.
 - c. Weight of Iron Sulfate per 1000 Sq. Ft. (92.9 Sq. m): Per soils analysis.
 - d. Weight of Agricultural Gypsum per 1000 Sq. Ft. (92.9 Sq. m): Per soils analysis.
 - e. Weight of Bonemeal per 1000 Sq. Ft. (92.9 Sq. m): Per soils analysis.
 - f. Weight of Superphosphate per 1000 Sq. Ft. (92.9 Sq. m): Per soils analysis.
 - g. Weight of Commercial Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): Per soils analysis.

2.7 MULCHES

- A. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50 to 60 percent of dry weight.
 - 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- 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.

2.8 PESTICIDES

- A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.9 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by 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 hydro-mulch 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. Limit turf subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches (100 mm). Remove stones larger than 1 inch (25 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
1. Apply superphosphate fertilizer directly to subgrade before loosening.
 2. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Mix lime with dry soil before mixing fertilizer.
 3. Spread planting soil to a depth of 4 inches (100 mm) on all lawn areas, and planting areas. Apply a 6-inch (150 mm) depth on natural grass sports fields, but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

- a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches (50 mm) of subgrade. Spread remainder of planting soil.
 - b. Reduce elevation of planting soil to allow for soil thickness of sod.
- C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 2. Loosen surface soil to a depth of at least 6 inches (150 mm). Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches (100 mm) of soil. Till soil to a homogeneous mixture of fine texture.
 - a. Apply superphosphate fertilizer directly to surface soil before loosening.
 3. Remove stones larger than 1 inch (25 mm) in any dimension and sticks, roots, trash, and other extraneous matter.
 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. Prepare area as specified in "Turf Area Preparation" Article.
- B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.
- C. Fill cells of erosion-control mat with planting soil and compact before planting.
- D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

- A. Sow seed with a no-till drill type seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h). Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of 12 lbs./1000 sq. ft.
- C. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.
- D. Protect seeded areas with erosion-control mats where shown on Drawings; install and anchor according to manufacturer's written instructions.
- E. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch (4.8 mm), and roll surface smooth.

3.6 HYDROMULCHING

- A. Hydromulching: Protect all newly seeded areas with Hydromulch. Mix specified 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 nonasphaltic fiber-mulch manufacturer's recommended tackifier.
 - 2. Apply slurry mix uniformly over all seeded areas to cover soil in all new seeded areas. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre (15.6-kb/92.9 sq. m) dry weight.
 - 3. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

3.7 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.
 2. Anchor sod on slopes exceeding 1:6 with steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
 3. Remove and dispose of sod netting prior to installing sod on sports fields and lawn areas.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches (38 mm) below sod.

3.8 TURF MAINTENANCE

- A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and re-mulch 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 (100 mm).
1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 2. Water turf with fine spray at a minimum rate of 1 inch (25 mm) per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowing. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowing to maintain the following grass height:
1. Mow tall turf type fescue to a height of 2-1/2 to 3 inches (63 to 75 mm) or less.
- D. Turf Post-fertilization: Apply fertilizer after initial mowing and when grass is dry.
1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) to turf area.

3.9 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
 - 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm).
 - 2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.10 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.11 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect temporary fencing or barricades and warning signs as required protecting newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- C. Remove non-degradable erosion-control measures after grass establishment period.

END OF SECTION 329200

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Plants.
2. Trees.
3. Shrubs.
4. Tree stabilization.
5. Edgings.
6. Soil amendments.
7. Weed control barriers.
8. Mulches.

- B. Related Sections:

1. Section 312000 "Earthwork" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
2. Section 328400 "Planting Irrigation."
3. Section 329200 "Turf and Grasses" for turf (lawn) planting and erosion-control materials.

1.3 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.
- D. 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.

- E. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
- F. Finish Grade: Elevation of finished surface of planting soil.
- G. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- H. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- I. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- J. Planting Area: Areas to be planted.
- K. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- 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. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- O. 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.
- P. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- Q. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated, including soils.
 - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
- B. Samples for Verification: For each of the following:
 - 1. Shredded Wood Mulch: 1-quart (1-liter) 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.
 - 2. Edging Materials and Accessories: Manufacturer's standard size, to verify color finish selected.
- C. Qualification Data: For qualified 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.
- D. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
 - 1. Manufacturer's certified analysis of standard products.
 - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- E. Agronomic Soils Test: Provide agronomic soils testing of stockpiled or imported soils and provide recommendations for soil amendments.
- F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required periods.
- G. Planting Schedule: Indicating planting dates for exterior plants.
- H. Warranty: Sample of special warranty.
- I. Qualification Data: For qualified landscape Installer showing the installer's professional certifications as required. 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.
- J. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
 - 1. Manufacturer's certified analysis of standard products.
 - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- K. Material Test Reports: For imported or manufactured topsoil.

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- L. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.
- M. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Experience: Five years experience in landscape installation in addition to requirements in Division 01 Sections.
 - 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 all of the following categories from the Professional Landcare Network:
 - a. Certified Landscape Technician – Exterior, with installation, maintenance and irrigation specialty area(s), designated CLT-Exterior.
 - 5. Pesticide Applicator: State licensed, commercial.
- B. Topsoil Analysis: Contractor will engage a soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil. Contractor shall obtain a copy of the data from the Owner and shall comply with its requirements.
 - 1. Report suitability of tested soil for lawns and landscape plant material growth.
 - a. State recommendations in weight per 1000 sq. ft. (92.9 sq. m) or volume per cu. yd. (0.76 cu. m) for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
- C. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- D. Measurements: Measure according to 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 (150 mm) above the root flare for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above the root flare for larger sizes.
- E. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
 1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.
- B. Bulk Materials:
 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.
- C. 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.
- D. Handle planting stock by root ball.
- E. 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 soil, peat moss, sawdust, or other acceptable material.

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.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of planting and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:
 1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of each service or utility.
 2. Do not proceed with interruption of services or utilities without Construction Manager's written permission.
- C. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
 1. Spring Planting: March 1st May 15th.
 2. Fall Planting: August 15th to October 15th.
- D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed according to manufacturer's written instructions and warranty requirements.
- E. Coordination (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas otherwise acceptable to the Architect.
 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.8 WARRANTY

- A. Special Warranty: Installer's standard form in which Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.

- b. Structural failures including plantings falling or blowing over.
 - c. 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 Substantial Completion:
 - a. Trees, Shrubs, Vines, and Ornamental Grasses: 24 months.
 - b. Ground Covers and Other Plants: 24 months.
- 3. Include the following remedial actions as a minimum:
 - a. Immediately remove dead plants. Replace immediately, unless required to plant in the succeeding planting season.
 - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - c. A limit of one replacement of each plant will be required except for losses or replacements due to failure to comply with requirements.
 - d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

1.9 MAINTENANCE SERVICE

- A. Initial Maintenance Service for Trees and Shrubs: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. 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: Three months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TREE AND SHRUB MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings 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; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots will be rejected.

2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 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.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

2.2 SHADE AND FLOWERING TREES

- A. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, or height and caliper indicated, complying with ANSI Z60.1 for type of trees required.
 1. Provide balled and burlapped trees.
 2. Branching Height: One-half of tree height.
- B. Small Upright Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:
 1. Stem Form: Single trunk.
 2. Provide balled and burlapped trees.
- C. Small Spreading Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:
 1. Stem Form: Multi-stem.
 2. Provide balled and burlapped trees.

2.3 DECIDUOUS SHRUBS

- A. Form and Size: Shrubs with not less than the minimum number of canes required by an measured according to ANSI Z60.1 for type, shape, and height of shrub.
 1. Shrub sizes indicated are sizes after pruning.
 2. Provide balled and burlapped or container-grown shrubs.

2.4 CONIFEROUS EVERGREENS

- A. Form and Size: Normal-quality, well-balanced, coniferous evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.
- B. Form and Size: Specimen quality as described, symmetrically shaped coniferous evergreens.
 - 1. Shearing Designation: Semi-sheared or lightly sheared (LS).
 - 2. Provide balled and burlapped trees.

2.5 GROUND COVER PLANTS

- A. Ground Cover: Provide ground cover of species indicated, established and well rotted in pots or similar containers, and complying with ANSI Z60.1.

2.6 PLANTS

- A. Perennials: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed, complying with requirements in ANSI Z60.1.

2.7 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, 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 No. 8 (2.36-mm) sieve and a minimum of 75 percent passing through No. 60 (0.25-mm) sieve.
- B. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- C. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 (0.30-mm) sieve.
- D. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

2.8 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 7.5; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch (13-mm) sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50 to 60 percent of dry weight.

2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

- B. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.9 FERTILIZERS

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 10 percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- D. 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. Size: 10-gram tablets.
 2. Nutrient Composition: 20 percent nitrogen. 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.
- E. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.
- F. Mycorrhizal Inoculant: Mycorrhizal inoculum (Endo/Ecto) capable of colonizing host plant roots.
 1. Product: Subject to compliance with requirements, provide Premier Tech Biotechnologies or “Mykes Transplant Enhancer” or approved equal.

2.10 PLANTING SOIL MIX

- A. ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1-inch (25 mm) or larger in any dimension and other extraneous materials harmful to plant growth.

- B. Topsoil Source: Reuse existing, native surface topsoil stockpiled on-site. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - 1. Supplement with imported or manufactured topsoil from offsite sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from agricultural land, bogs, or marshes.
- C. Planting Soil Mix: Blend topsoil with coarse organic compost at a rate of 3-parts topsoil to 1-part compost to create planting soil mix.

2.11 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing for tree planting rings in lawn areas, consisting of one of the following:
 - 1. Type: Shredded Cypress wood mulch or 50/50 Cypress/Cedar wood mulch blend.
 - 2. Size Range: 3-inches maximum, 1/4-inch minimum.
 - 3. Color: Natural.
- B. Mineral Mulch: Hard, durable Kansas river rock, angular, washed free of loam, sand, clay, and other foreign substances of following type, size range and color:
 - 1. Size Range: 3/4-inch (22 mm) maximum to 1/4-inch (7 mm) minimum.
 - 2. Color: Multi-colored aggregate ranging from charcoal to tan-beige.

2.12 WEED-CONTROL BARRIERS

- A. Granular, film forming, chemical weed barrier to be installed in all mineral and organic mulch areas:
 - 1. Product: Subject to compliance with requirements, provide the following or approved equal:
 - a. Treflan.
- B. Non-woven Geotextile Filter Fabric: Install below aggregate mulch in planting bed areas. Non-woven polypropylene or polyester fabric 3 oz./sq. yd. (101 g/sqm) minimum equal to Typar T-140N. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis and acids.

2.13 TREE STABILIZATION MATERIALS

- A. Proprietary Staking-and-Guying Devices: Proprietary stake and adjustable tie systems to secure each new planting by plant stem; sized as indicated and per manufacturer's written recommendations.

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1. For up to 4-inch caliper trees. Includes, three polypropylene guy lines (3/4-inch by 12 feet (800 lb. test), olive color, UV resistant and (3) nickel plated spring cam-lock tension clips and (3) arrowhead nylon anchors with driver device.
2. Products: Subject to compliance with requirements, provide the following or approved equal:
 - a. Arborbrace Tree Guying System; Model ATG-R.

2.14 PESTICIDES

- A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.15 BED EDGING

- A. Recycled Plastic Bed Edging: Black flexible plastic, low profile, straight, PVC bed edge equal to Oly-Ola Edgings model "Bric-Edg".
 1. Size: 0.115-0.130-inch thick by 2-inches minimum height; and 2.75-inch width.
 2. Material: Manufacturer's standard black UV resistant material with manufacturer's standard connecting "H" clips.
 3. Stakes: Provide "Super-Edg" steel stake at 12-inch length. Provide stakes at 24-inch on center.
- B. Manufacturer: Provide products by the following or approved equal.
 1. Oly-Ola Edgings, Inc.
 2. Perma-Loc.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.
- D. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.
- E. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.3 PLANTING AREA ESTABLISHMENT

- A. Loosen subgrade of planting areas to a minimum depth of 6 inches (150 mm). Remove stones larger than 1-1/2 inches (38 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
1. Apply fertilizer directly to subgrade before loosening.
 2. Spread planting soil to a depth of 6 inches (150 mm) but not less than required to meet finish grades after natural settlement. Do not spread if planting soil mix or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 4 inches (100 mm) of subgrade. Spread remainder of planting soil.

- B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward. Excavations with vertical sides are not acceptable. 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.
 - 1. Excavate approximately three times as wide as ball diameter for balled and burlapped stock.
- B. Subsoil and topsoil removed from excavations may be used as planting soil.
- C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
 - 1. Hardpan Layer: Drill 6-inch- (150-mm-) diameter holes, 24 inches (600 mm) apart, into free-draining strata or to a depth of 10 feet (3 m), whichever is less, and backfill with free-draining material.
- D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE AND SHRUB PLANTING

- A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1.
- B. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades.
 - 1. Completely saturate and cover root ball with granular plant enhancer on entire root ball per manufacturer's recommendations.
 - 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. Wet the root ball and install mycorrhizal granules over root ball, place root ball in pit and add remaining granules around pit close to root ball per manufacture recommendations.

4. Backfill with planting soil mix 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.
 5. Place slow-release planting tablets in each planting pit when pit is approximately three quarters filled. Install three tablets minimum per tree or per manufacturer's recommendations. Place tablets beside root ball about 1-inch from root tips. Do not place tablet in bottom of hole.
 6. Continue backfilling process. Water again after placing and tamping final layer of planting soil mix.
- C. Set container-grown stock plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades.
1. Carefully remove root ball from container without damaging root ball or plant.
 2. 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.
 3. Place planting tablets in each planting pit when pit is approximately three- quarter filled. Install three tablets minimum per tree or per manufacturer's recommendations. Place tablets beside root ball about 1-inch from root tips. Do not place tablet in bottom of hole.
 4. Continue backfilling process. Water again after placing and tamping final layer of planting soil mix.
- D. Organic Mulching: Apply 3 inches (75 mm) average thickness of organic mulch extending 24 inches (600 mm) beyond edge of planting pit. Do not place mulch within 2 inches (50 mm) of trunks or stems for all trees/plants set individually within lawn areas.
- E. Aggregate Mulching: Install geo-textile weed barrier fabric over finish grade. Apply 3-inch (75-mm) average thickness of mineral mulch in all planting beds to completely cover the weed barrier fabric. Ensure finish grades along walks, curbs, PVC bed edging and concrete mow strips is lowered to accommodate the 3-inch depth of aggregate mulch before installing fabric and mulch.
- F. 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 the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 TREE AND SHRUB PRUNING

- A. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

3.7 TREE STABILIZATION

- A. Install trunk stabilization as follows 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 according to manufacturer's written instructions.

3.8 GROUND COVERS, GRASSES, AND PERENNIALS PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs and vines 12 inches (300 mm) apart or as indicated in even rows with triangular spacing.
- B. Use planting soil mix for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. For rooted cutting plants supplied in flats, plant each in a matter that will minimally disturb the root system but to a depth not less than two nodes.
- E. Work soil around roots to eliminate air pockets and leave a 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 PLANTING AREA MULCHING

- A. Organic Mulch Areas: Install chemical weed control barriers before installing organic mulch, place on soil and after mulching on top of finish mulch according to manufacturer's written instructions.
- B. Aggregate Mulch Planting Areas: Install filter fabric over planting soil mix in all planting beds and secure to subgrade with galvanized steel staples per manufacturer recommendations. Install aggregate over fabric and ensure fabric is entirely covered with aggregate mulch.
 - 1. Ensure circular openings are cut into the weed barrier fabric to allow space for the plants to grow. Provide 6-inch minimum opening for grasses and perennials and 18-inches for all shrub plantings.

3.10 EDGING INSTALLATION

- A. Plastic PVC Edging: Install plastic edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 24 to 48-inches (600mm-1200

mm) apart, driven at opposing angles to minimize frost heave. Top of edge shall be a maximum of ½-inch above finish grade of turf sod.

3.11 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. Spray or treat as required to keep trees and shrubs free of insects and disease.
- 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.

3.12 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with 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. Pre-Emergent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.13 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. 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.
- C. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.14 DISPOSAL

- A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

LEE'S SUMMIT MIDDLE SCHOOL #4
PACKAGE 3 – BUILDING & SITE
LEE'S SUMMIT, MISSOURI

13-20102-00
8 OCTOBER 2020
PERMIT SET

END OF SECTION 329300

PLANTS

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